# TECHNOLOGY REVIEW

*May* 1959

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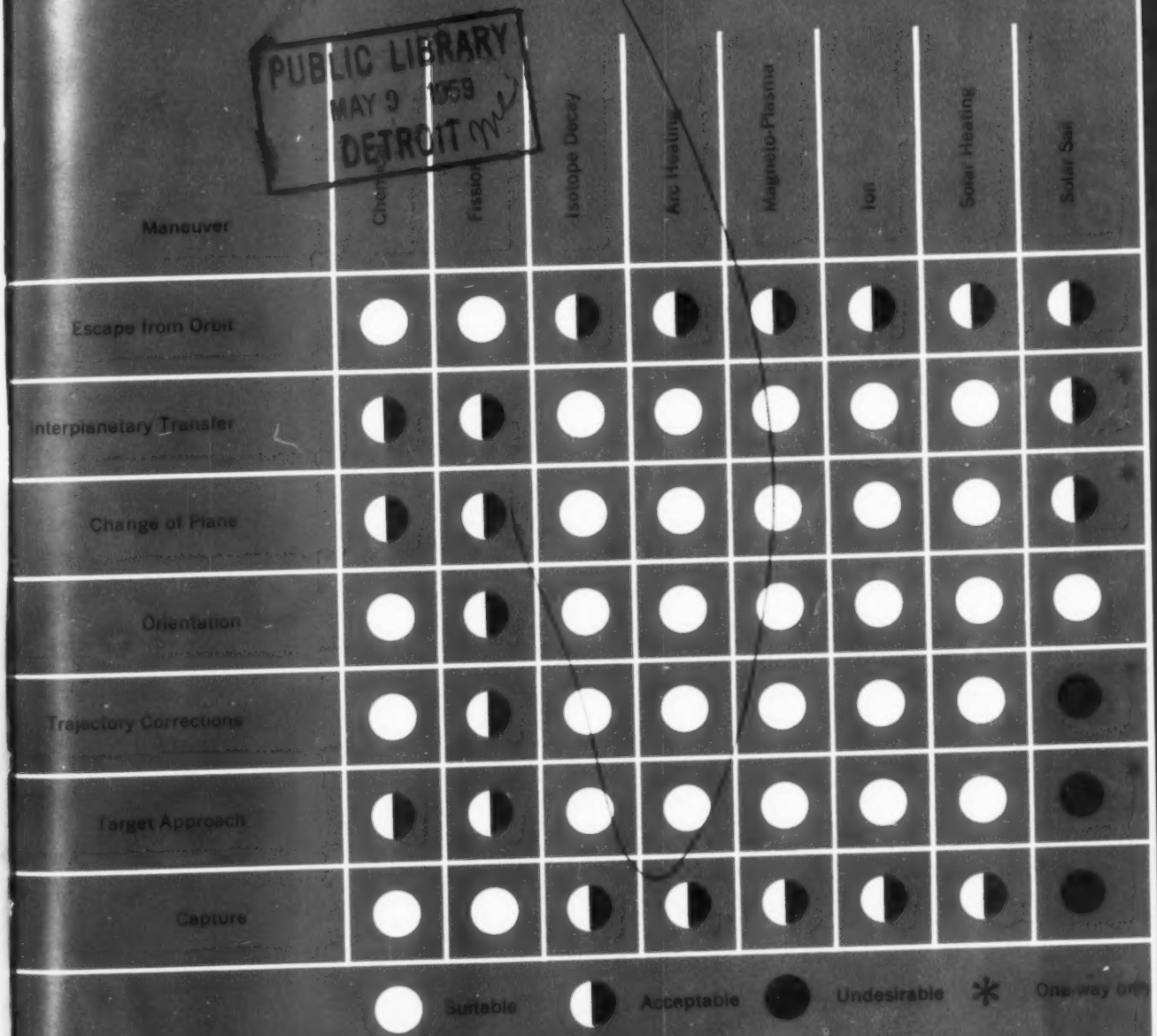
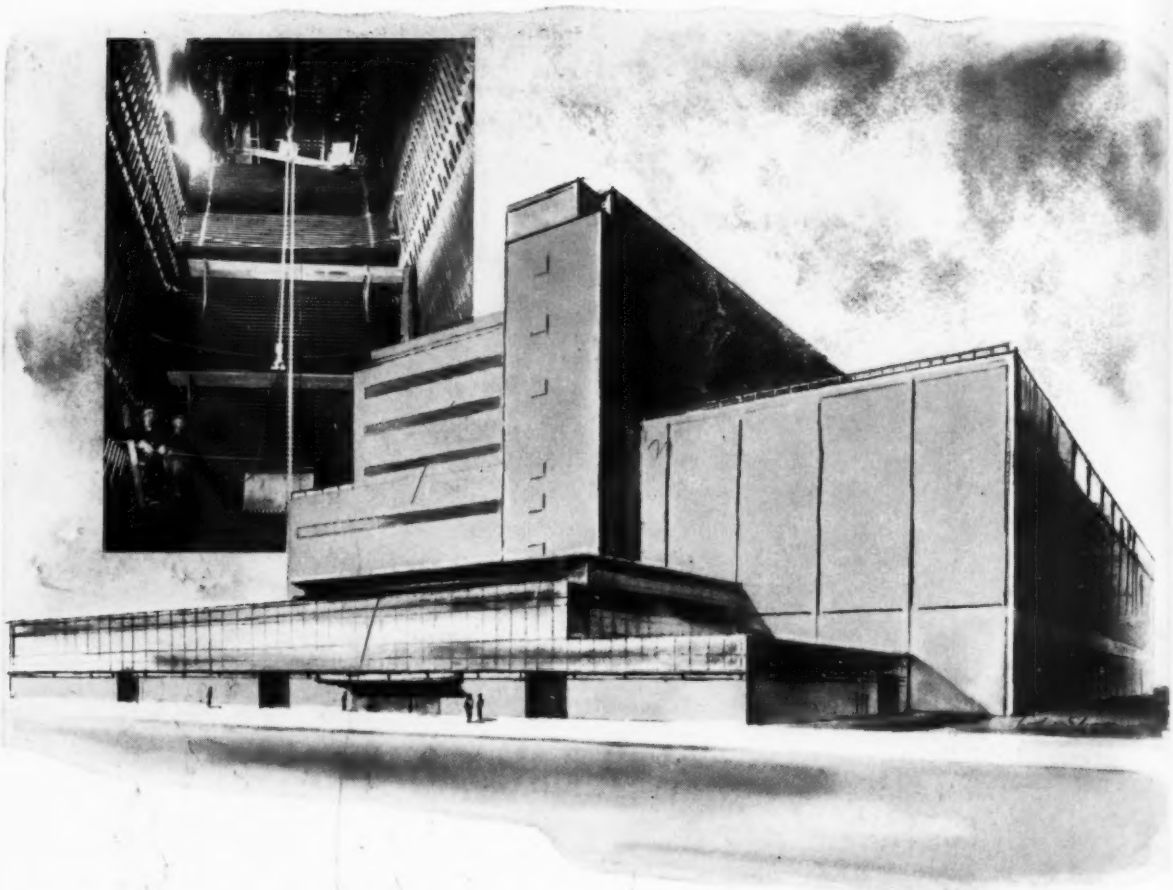


"CREATIVE ENGINEERING" POINTS THE WAY TO HIGHER POWER STATION EFFICIENCY



# C-E invades new regions of steam pressure and temperature for world's most efficient power station

The completion of the plant pictured above . . . the Eddystone Station of the Philadelphia Electric Company . . . will mark an outstanding achievement in electric power generation.

Scheduled to go into service late this year, Eddystone will produce steam at the highest pressure and temperature ever used in commercial power practice—*5000 lb per sq in and 1200°F.* By so doing, it is expected to generate electricity at a fuel rate of less than two-thirds of a pound of coal per kilowatt-hour—a rate which will establish a new world's record for power station efficiency.

Eddystone's steam will be produced by a C-E Sulzer Monotube Steam Generator, a small portion of which is shown in the photo inset. This 14-story-high boiler is comprised essentially of about 170 miles of small-diameter tubing, much of it made of chromium and nickel alloys. At full load, its twin furnaces will consume about 100 tons of pulverized coal an hour – 40 average carloads per day.

Creative Engineering is the C-E approach to providing the most advanced designs of boilers for all steam requirements—from those of small industrial and institutional plants to the largest utility power stations.

"CREATIVE ENGINEERING" is the reason for the leadership attained by C-E products. The products which bear this mark of leadership include:

all types of steam generating, fuel burning and related equipment • nuclear power systems • paper mill equipment • pulverizers • flash drying systems • pressure vessels • soil pipe

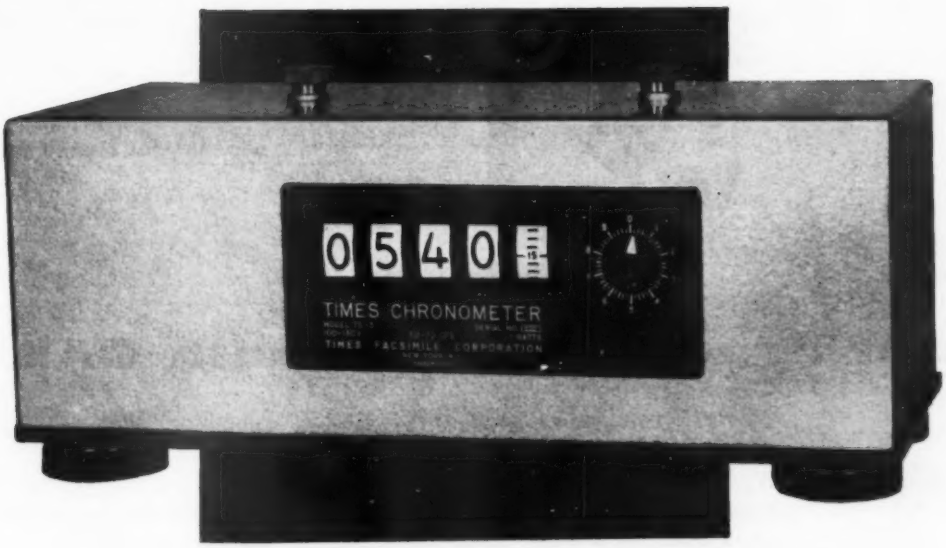
**COMBUSTION ENGINEERING**

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

C-204

THE TIME INDICATOR UNIT

# accurate to 1 second in 12 days




**TIMES MODEL TS-3 CHRONOMETER**

Program timer, pulse generator and clock. Timing assemblies, driven by the clock motor, provide momentary contact closings at rate of

**• ONCE A SECOND • ONCE A MINUTE • ONCE AN HOUR**

also optional frequency or pulse outputs as specified in range between 10 and 1000 cps.

PRICE: $950.00, F.O.B. Factory.

Optional frequency output, $50.00 each.

*Write for details.*

**TIMES FACSIMILE CORPORATION**

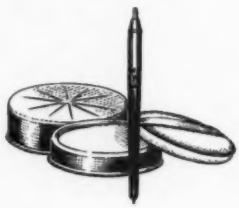
540 West 58th Street, New York 19, N. Y.



THE TECHNOLOGY REVIEW, May, 1959, Vol. LXI, No. 7. Published monthly from November to July inclusive at Emmett Street, Bristol, Conn. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription, $4.00: Canadian and Foreign subscription, $4.50. Entered as second-class matter December 23, 1949, at the Post Office, at Bristol, Conn., under the Act of March 3, 1879.

*. . . greases or gloves*

*. . . pens or powders*



*. . . varnish or vases*

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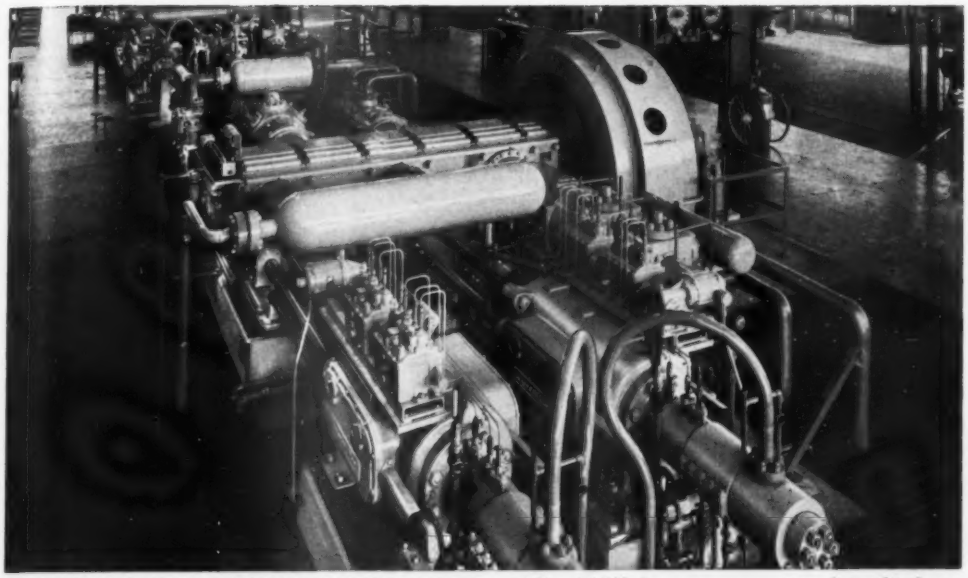
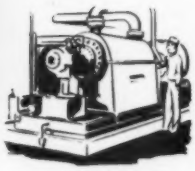
## with INGERSOLL-RAND



Seven electric-driven Ingersoll-Rand reciprocating compressors totaling 21,900 horsepower are at work in this large ammonia synthesis plant. The units in the foreground compress mixed gases to more than 12,000 pounds per square inch.

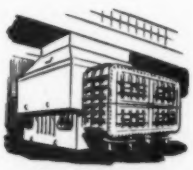
*also means* LEADERSHIP in



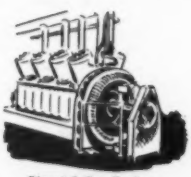
Centrifugal Pumps

Rock Drills

Air & Electric Tools



Steam Condensers



Diesel & Gas Engines

### Here's What Compressor Engineering at Ingersoll-Rand can mean to you...

TODAY, air power is one of the industry's most vital requirements. Compressed air and gases are the "breath of life" to chemical and process industries, refineries, power plants, steel mills, manufacturing plants, mines and all types of construction jobs. Hence, compressor and blower engineering offers an exciting and ever-expanding field of challenging opportunities that are virtually industry-wide.

Ingersoll-Rand is the world's largest manufacturer of air and gas compressors and Turbo-Blowers – supplying over 1000 different sizes and types, ranging from ½ hp to 17,250 hp, in pressures from vacuum to 35,000 psi.

Ingersoll-Rand also manufactures pumps, rock drills, diesel and gas engines, vacuum equipment, blowers, air and electric tools and specialized industrial machinery as illustrated at the right. These products require engineering know-how in their design, manufacture and field application.

If you are looking for a leadership career with long-range job security and excellent opportunities for advancement, you'll find it at Ingersoll-Rand. For further details, contact your Placement Office, or write to Ingersoll-Rand, 11 Broadway, New York 4.

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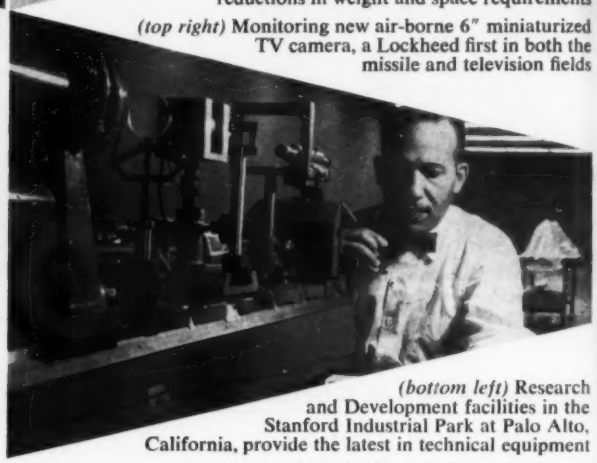
*Among the many graduates of Massachusetts Institute of Technology at Ingersoll-Rand are:* L. C. Hopton, 1926, *First Vice-President and Secretary;* P. J. Bentley, 1925, *Vice-President.*

*(top left)* Transistorizing missile flight control systems by Lockheed scientists has meant significant reductions in weight and space requirements

*(top right)* Monitoring new air-borne 6″ miniaturized TV camera, a Lockheed first in both the missile and television fields



*(bottom left)* Research and Development facilities in the Stanford Industrial Park at Palo Alto, California, provide the latest in technical equipment

*(bottom right)* Setting up a diffraction image for a research study in infrared optics

## EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Lockheed Missiles and Space Division is engaged in all areas of scientific activity – from concept to operation – in missile and space technology.

Important basic research and development work is being conducted in such fields as advanced systems research; nucleonics; physics; chemistry; mathematics; metallurgy; design; test; electronics; aerothermodynamics; gas dynamics; structures; and astrodynamics. Programs under investigation at Lockheed include: man in space; space communications; space physics; re-entry; ionic and nuclear propulsion; cryogenics; magnetohydrodynamics; oceanography; computer development; noise suppression and damage; materials and processes; boundary layer control; electromagnetic wave propagation and radiation; and operations research and analysis.

The Division is systems manager for such major, long-term projects as the Navy Polaris FBM; Discoverer Satellite; Army Kingfisher; Air Force Q-5 and X-7 and other important research and development programs.

Headquarters for the Division are at Sunnyvale, California, on the San Francisco Peninsula, and research and development facilities are in the Stanford Industrial Park in Palo Alto and at Van Nuys in the San Fernando Valley. Facilities are new and modern and include the latest in technical equipment. A 4,000 acre Division-owned static test base in the Ben Lomond mountains near Santa Cruz provides for all phases of static field test. In addition, flight test facilities are provided at Cape Canaveral, Florida and Vandenberg AFB, Santa Maria, California.

Scientists and engineers of outstanding talent and inquiring mind are invited to join us in the nation's most interesting and challenging basic research and development programs.

Write: Research and Development Staff, Dept. E-52, 962 W. El Camino Real, Sunnyvale, California. U.S. Citizenship required.

*"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics."* NATIONAL MISSILE INDUSTRY CONFERENCE AWARD

**Lockheed** / **MISSILES AND SPACE DIVISION**

*Weapons Systems Manager for Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; Air Force Q-5 and X-7*

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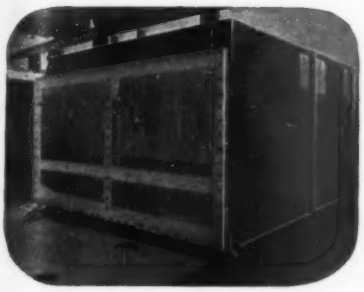
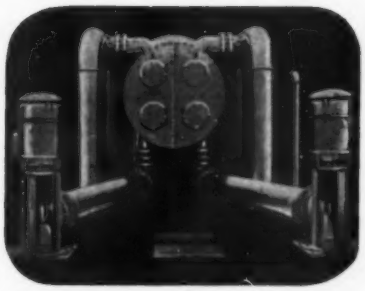
*and auxiliary equipment*

# HOW C.H. WHEELER CONDENSER DESIGN saves space...



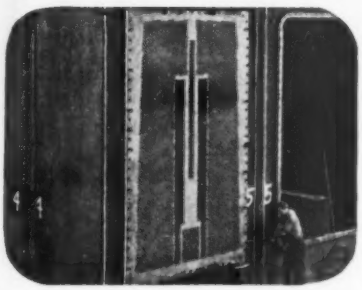
**Head Room** problems are solved by compact condensers like this one. Turbine floor to basement floor, in this case, is only 20 ft. The Unit has 65,000 square feet of condensing surface.

**Rectangular Cross Section** makes C.H. Wheeler Condensers adaptable to nearly any space or condenser arrangement because the length, width and height of any Wheeler Unit can be varied almost at will.

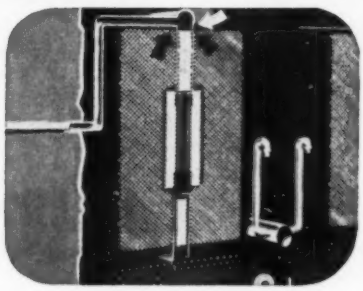


**But Wheeler Doesn't** limit itself to rectangular design. A round cross section worked out better here, for example, at the first planned gas-steam turbine station ever designed and built in United States.

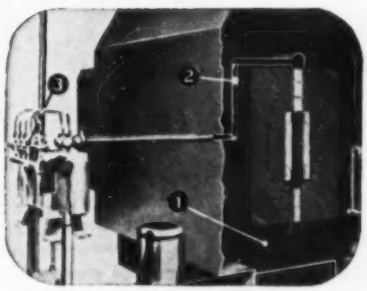
## improves power generating efficiencies...



**Triple Lane tube layout,** another design feature, provides 3 pathways for steam travel, utilizes maximum cooling surface and produces higher condenser vacuums for power generating stations.

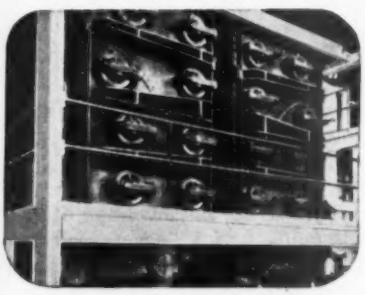


**Location of air-vapor takeoff** speeds steam travel and allows steam to penetrate to the peripheries of all tubes. It thus improves condenser efficiencies and overall power station operation as well.

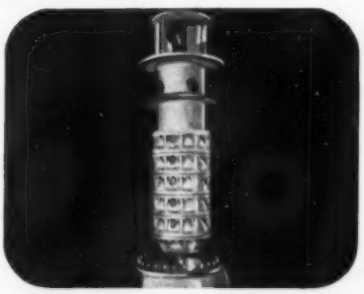



**Deaeration of condensate** not to exceed 0.01 cc. oxygen/liter is available with special Wheeler designs. Note the Deaerating Bars (1), the Air-Vapor Suction Line (2), and Tubejet® Ejectors (3).

## and reduces maintenance



**Patented Reverse Flow** permits flushing tubes and sheets without shutting down Unit, during full load with either or both circulating pumps operating. No additional circulating water inlet or discharge piping necessary with C.H. Wheeler's Reverse Flow.



**"Pull-Out" Condensate Pumps** simplify maintenance because entire pumping element, including all rotating parts, can be removed without disturbing either the pump barrel or the piping connections.

**C. H. Wheeler Circulating Pumps,** like Condensate Pumps, are easy to inspect and maintain because of "Pull-Out" design. In addition, shafts are heat treated alloy steel and impellers are statically and dynamically balanced for trouble-free operation.

C. H. Wheeler has been designing and building condensers since 1903; has developed such features as Dual Bank Design and Reverse Flow.

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# 25 YEARS AGO

*A column of items of interest culled from The Technology Review's files*

■ In May, 1934, The Review reported that "convincing testimony as to the quality of graduate work offered at Technology is found in the recently completed survey of graduate schools conducted by a committee of the American Council on Education. In this survey, the first comprehensive study of American graduate work, Technology was rated as distinguished in 10 of the 11 fields in which it offers work for the doctorate. No other institution had such a high percentage of its work rated as distinguished. The only field, Zoölogy, in which the Institute was not listed as distinguished was judged as satisfactory. . . .

"The study covered 35 fields of knowledge, a list of which was sent to the deans of all graduate schools known to be offering work for the doctorate. . . . The secretary of the national learned society in each field was then asked to submit a list of 100 eminent scholars. To these scientific juries were sent lists of the institutions offering work in their fields and the names of the graduate faculty of each. These scholars, numbering more than 2,000, checked the institutions which in their judgment had adequate staff and equipment to prepare candidates for the doctorate, and starred the departments of highest rank.

"Of the 48 states in the Union, 20 have no institution which in the judgment of the juries is adequately staffed and equipped to offer work for the doctorate in any one of the 35 fields considered. Only five institutions (M.I.T., Princeton, Chicago, Harvard, CalTech) were judged as qualified or distinguished in every field in which they offered doctorates."

■ Additions to the Institute staff, effective the following autumn, were announced as follows:

*Francis Bitter* as Associate Professor in the Department of Mining and Metallurgy; *Joseph H. Keenan, '22,* as Associate Professor in the Department of Mechanical Engineering; *Robley D. Evans* as Assistant Professor in the Department of Physics; and *Edwin R. Gilliland, '33,* as instructor in the Department of Chemical Engineering.

■ Aeronautical honors came to two Alumni: to *Frank W. Caldwell, '12,* the annual Collier Trophy of the National Aeronautic Association; to *Captain Albert F. Hegenberger, '17,* the Distinguished Flying Cross.

Mr. Caldwell's award was for his invention of the controllable pitch propeller which "has revealed a new horizon in aeronautics and taken the limits off speed. Henceforth, our pace through the air will be as fast as the daring and imagination of engineers."

Captain Hegenberger's decoration was cited as being "for extraordinary achievement while participating in aerial flights. By his initiative, energy, and courage, [he] rendered exceptionally valuable services to the Government of the United States in the execution of a series of aerial flights culminating with a solo instrument flight and landing in May, 1932, in connection with the testing and development of the Air Corps system of Instrument Flying and Landing."

CHECK POINTS FOR CHOOSING AN ENGINEERING FIRM—

# PICK ONE WITH EXTENSIVE PROCESS INDUSTRY EXPERIENCE

Choose a firm with a staff and facilities geared to the design, engineering and construction of chemical and petrochemical plants —and with a *proven* record in this area of industry.

The Lummus Company, for example, has built over 800 chemical process units in the last 50 years. Among them have been the world's largest butadiene plant, the world's first commercial plant to make high-pressure acetylene chemicals, and one of the least expensive anhydrous ammonia plants ever built.

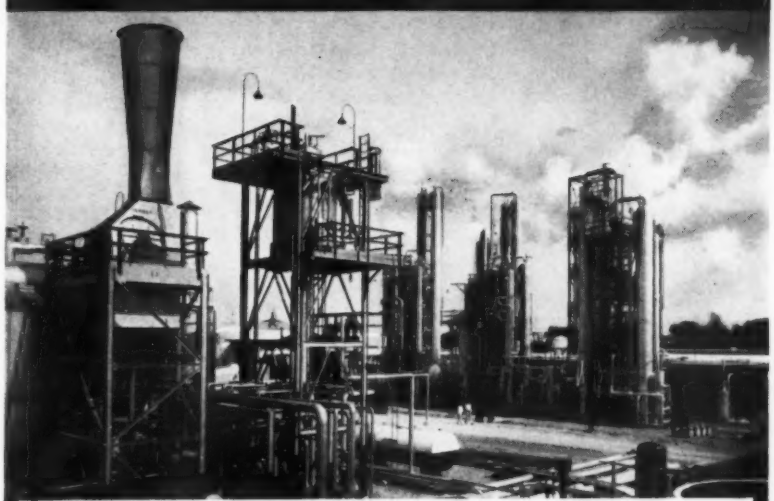
Lummus maintains a staff of highly trained specialists in seven branch offices and subsidiaries throughout the world. They are thoroughly experienced in chemical plant design and construction.

Then, too, Lummus has an Engineering Development Center to bridge the gap between laboratory research and commercial plant operation. The Center has extensive chemical pilot plant facilities in operation, and is equipped for designing and building new pilot units.

Call in Lummus when you begin plans on your next chemical plant.

**Visit the Lummus Exhibit, Fifth World Petroleum Congress Exposition, New York Coliseum, June 1-5, 1959**

## CHEMICAL PLANTS— A SPECIALTY OF LUMMUS



**ABOVE** — World's first full-scale, high-pressure acetylene chemicals plant at Calvert City — engineered and constructed by Lummus for General Aniline & Film Corporation.

**BELOW**—Just a few examples from Lummus' long list of outstanding chemical projects.

| PRODUCT | COMPANY | LOCATION |
|---|---|---|
| Vinyl Acetate | Air Reduction Chemical Co. | Calvert City, Kentucky |
| Phenol-Acetone | Progil-Electro-chimie | Pont de Claix, France |
| Anhydrous Ammonia | Food Machinery & Chemical Corp. (Westvaco Chlor-Alkali Division) | South Charleston, West Virginia |
| Phthalic Anhydride | Pittsburgh Coke & Chemical Co. | Neville Island, Pa. |
| Epon Resins | Shell Chemical Corp. | Houston, Texas |
| Bisphenol | Shell Chemical Corp. | Houston, Texas |
| Tetramer, Cumene, Phenol-Acetone | Societe des Chimiques des Derives du Petrole | Antwerp, Belgium |
| Sulfuric Acid | Inland Chemicals Canada Ltd. | Fort Saskatchewan, Alberta, Canada |
| Ethylene Oxide-Glycol | Calcasieu Chemical Corp. | Lake Charles, La. |
| Ethylene | Petroleum Chemicals, Inc. | Lake Charles, La. |
| Beryllium Metal | The Beryllium Corp. | Ashmore, Pa. |

LUMMUS

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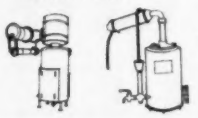

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# MAIL RETURNS

## A Spelling Problem

FROM EDWARD ZETTERBERG, '25:

Would the famous Russian chemist who developed the Periodic Classification of the Elements recognize his name if he were alive today? Textbooks used have these versions.

Mendelejeff, *Vitalized Chemistry* by Jardine
Mendeleyeff, *New World of Chemistry* by Jaffey
Mendeleyev, *Biography of Mendeleyev* by Posin
Mendeleeff, *General College Chemistry*, by Richardson and Scarlett

Recently 20 pupils in a chemistry class were asked to spell this man's name. The spelling was different in every case:

| | | | | |
|---|---|---|---|---|
| Mendoloeff | Mandeleff | Mendeleof | Mendelieth | Mendolaieff |
| Mendelleuf | Mendelauf | Mendeleiff | Mendalith | Mendaleff |
| Mendaleuf | Mendalaen | Mendelief | Mendeljeff | Mendeloyeph |
| Mendalaiph | Mendalif | Mendolieff | Mendleth | Mendolief |

Is confidence in the accuracy of science affected by authors using different spelling for the name of a great chemist?

Maybe we ought to forget about the spelling and just call him the Great Periodic Man.

*Muncie, Indiana*

## Fission and Combustion Nomenclature

FROM FRANK S. MACGREGOR, '07:

In your November issue . . . I have been bothered by two expressions, namely, "propulsive reactor" and "power reactors" . . . I have never heard a fire box or boiler described by the purpose for which the heat is to be used. . . . Would be pleased to learn if the new nomenclature is to be considered correct.

*Wilmington 5, Del.*

*[Asked about this, Professor Manson Benedict, '32 of the M.I.T. Department of Nuclear Engineering, said: "It has become customary to characterize reactors by the purpose served by the plant of which they are a part. I agree with Mr. MacGregor that this seems inconsistent with usage in plants employing combustion as a heat source."]*

Chas. Pfizer & Co., Inc.,
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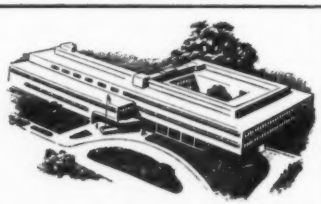

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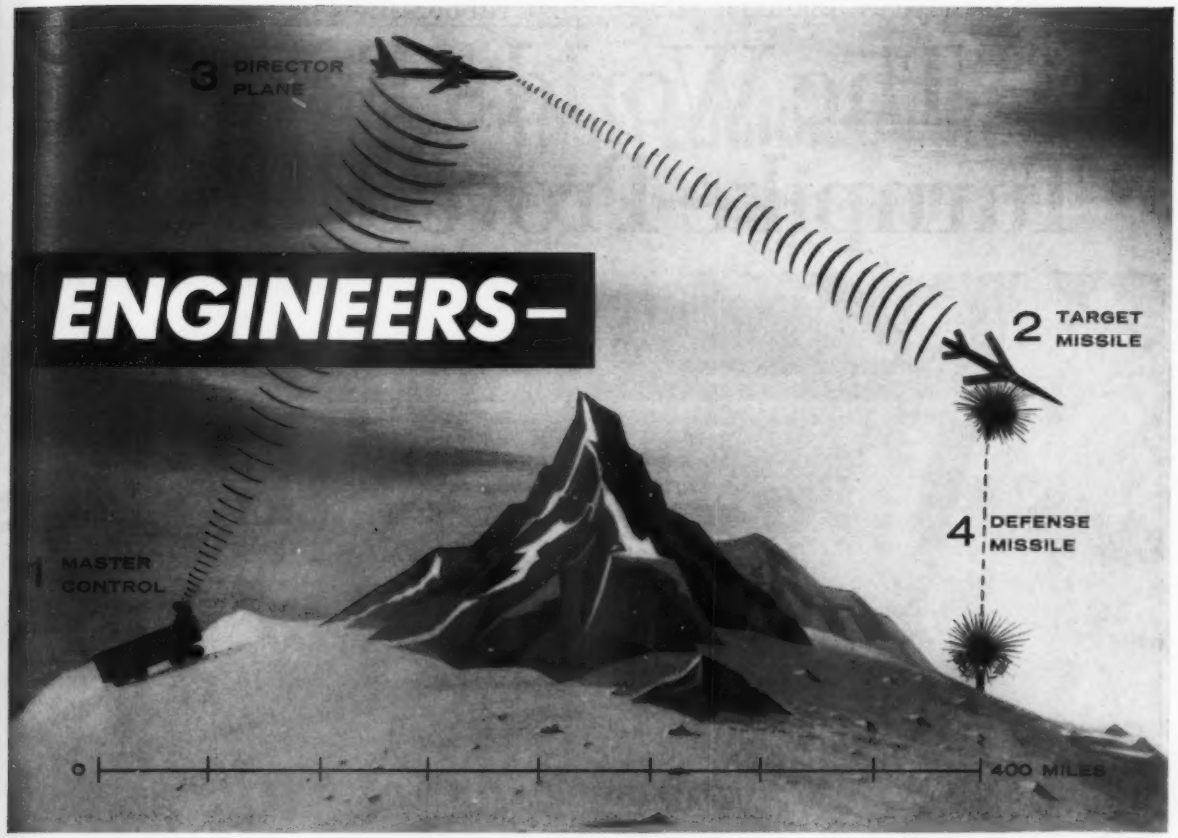


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# The Technology Review

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EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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*On April 5, Samuel C. Prescott, '94, observed his 87th birthday. Professor of Industrial Biology, Emeritus, and author of* When M.I.T. Was Boston Tech, *he can be found regularly in his office in the Samuel Cate Prescott Laboratories.*

M.I.T. Photo

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## *Geophysical Pioneers Stimulate Research in Earth Sciences*

*Cecil H. Green, '23, and Mrs. Green of Dallas, Texas, have given 30,000 shares of the stock of Texas Instruments Incorporated, having a market value on April 1 of $2,527,500, to M.I.T. to provide for the construction of a building to house the Center for Earth Sciences. Mr. and Mrs. Green are pictured above in the Dallas plant of Texas Instruments, a leading manufacturer of transistors and electronic systems for defense. Mr. Green is a vice-president and member of the board of directors of this company.*

*Mr. Green's interest in the Institute has been intense and enduring since he enrolled as a student from a foreign country in 1921. Born in Manchester, England, and brought up in Vancouver, British Columbia, he came to M.I.T. after studying at the University of British Columbia. He received both the bachelor's and master's degrees from M.I.T., has served on the National Nominating Committee of the M.I.T. Alumni Association, and in June, 1958, was elected a special term member of the M.I.T. Corporation.*

*While employed by the General Electric Company in Schenectady, N.Y., Mr. Green met and married Miss Ida Flansburgh, who has shared with him both the life of a pioneer in geophysical exploration and his deep interest in the advancement of science and education. After working as a research engineer with other companies, Mr. Green joined the newly formed Geophysical Service Incorporated in 1930 and worked in many areas with seismograph crews. He became president of the company in 1950 and chairman of its board of directors in 1955. This company is now a wholly owned subsidiary of Texas Instruments Incorporated.*

The Technology Review

VOL. 61, NO. 7 MAY, 1959

# The Trend of Affairs

## New Facilities to be Focused on the Sciences of the Earth

■ M.I.T. established an interdepartmental Laboratory of Earth Sciences two years ago to foster closer integration of research in geology, geochemistry, geophysics, meteorology, and oceanography. A multi-story building is being planned now to house this new Center's research tools, library, seminars, and offices. Such an addition to the Campus has been made possible by the gift of $2,527,500 announced last month. It was the largest gift that the Institute has received in many months, and came from Cecil H. Green, '23, and Mrs. Green of Dallas, Texas.

"Within the all-encompassing field of science itself, the importance of the earth sciences has been increasing with almost explosive force," Mr. Green observed. "For our country to maintain leadership in these areas in competition with other nations, or even to keep abreast in the race for new knowledge, we believe it imperative that greater effort be devoted within these fields, and to center that effort where it can bear fruit most quickly.

"We consider M.I.T. to be in an especially favorable position to make effective contributions to our basic knowledge in these disciplines and to do so with maximum dispatch. The earth sciences, as well as a broad range of other and supporting sciences, already are a part of M.I.T.'s curriculum and the Institute possesses both the scholarship and the leadership essential for this job. Hence it can go to work at once, and with promise of truly rewarding results."

Mr. Green also expressed enthusiasm for programs of research and graduate study in the earth sciences elsewhere. He particularly pointed out the projects being undertaken at the new Graduate Research Center at Southern Methodist University in Dallas. He is a member of this Center's board of trustees, as well as a special term member of the M.I.T. Corporation.

Mr. Green expects the S.M.U. Center to fulfill a great need for advanced studies in earth sciences in the Southwest, the nation's principal petroleum producing area, and he predicted that its eventual impact would be comparable to that of M.I.T. programs in the earth sciences and other broad fields of graduate study and scientific research. Mr. Green emphasized, however, that the S.M.U. Center's projects are in the formative stage, whereas M.I.T. has such programs well under way. The latter need only increased emphasis and support to become almost immediately productive of important new knowledge vital to the security of our country.

M.I.T. has been one of America's leading educational institutions in the earth sciences for nearly a century. Its first president, William Barton Rogers, was the country's outstanding geologist in his day. The nation's first Course in Meteorology was given at M.I.T. in 1928. For many years the Institute has co-operated with the Woods Hole Oceanographic Institution, sharing staff members, students, and technological problems, and even closer ties are now envisioned. The Institute also has introduced new educational methods in geology and geophysics, such as summer and co-operative training programs in the field and with industrial concerns.

The Institute's facilities applicable to the earth sciences now include a variety of large computers, a nuclear reactor, outstanding laboratories of hydrodynamics, acoustics, and electronics, the Lindgren library, and the Schwarz Map Room. Many of these facilities especially helpful to observational, experimental and theoretical scientists interested in the earth, sea, and atmosphere will be brought together in the new building which has been made possible by the gift from Mr. and Mrs. Green.

"Modern science, with interest centered on the atom and space, has neglected the geo-sciences, meteorology and oceanography," President Julius A. Stratton, '23, observed in his acknowledgment of the grant. "What is underneath the surface of the earth, what goes on in the oceans, how mountains are formed, and how the atmosphere works are some of the questions earth scientists hope to answer in the future. It is clear that tomorrow's geologists, together with meteorologists and oceanographers must work in close co-operation.

"The practical value of such studies will aid in every segment of the nation's welfare and defense. To assure adequate supplies of fresh water needed by expanding cities, we must understand the cycle of water in nature. Extended prediction and the possibility of

large-scale weather control are no longer idle speculation. Exploitation of our mineral resources depends on new techniques of mineral exploration and better understanding of how mineral deposits are formed.

"Today the earth sciences stand on the threshold of great advances, as did electronics 10 years ago. Results from the International Geophysical Year have made it clear that much is to be done in understanding the mysteries of the universe. It is also clear that the Soviet Union has made notable advances in areas such as prospecting by geo-chemistry and weather control.

"This magnificent grant of Mr. and Mrs. Green will permit a major effort to be made for a better understanding of our physical environment. All the recent advances in electronics, physics, chemistry, and mathematics will be brought to bear on these problems. Geologists, chemists, physicists, meteorologists, and oceanographers now will be able to work side by side in a basic and applied scientific program which will have, I am certain, the greatest impact on our economy and society as a whole."

## Reporters without a Deadline

■ Fifty newspaper reporters, columnists, and editorial writers crammed for 12 hours at M.I.T., for 12 more at Harvard, then met again on an April Saturday to hear six more lectures. This was not an off-the-record meeting. Nevertheless, not a line of what was said appeared in the fat Sunday newspapers because this was a new kind of press conference. It was a seminar, arranged by the Nieman Foundation with the help of the Harvard News Office and M.I.T. Public Relations Office, to increase the journalists' understanding of scientific concepts and technological developments that now underlie much of the news. It was intended not to produce headlines but to increase the accuracy of reporting in the future.

President Stratton of M.I.T. opened this three-day Seminar for Science Writers with a discussion of major educational and scientific problems, and Professor Jerome B. Wiesner spoke candidly about the relations between government and science. Professor Norbert Wiener pointed out mathematical similarities in the Charles River's waves, brain waves, electrical distribution systems, and the orbits of asteroids. Professors Cyrus Levinthal, Alexander Rich, and Salvador E. Luria plunged into details of molecular biology, viruses, and cancer. Professor Hurd C. Willett emphasized the mysteries of meteorology. Professor Robley D. Evans and Robert A. Dudley covered biological effects of radiation. Professor Sanborn C. Brown, '44, compared Russian and American thermonuclear experiments, Herbert Weiss of Lincoln Laboratory went into the mathematics of interplanetary communication, and Professor Martin Deutsch, '37, explained the fascination of pure physics.

An equal number of distinguished members of the Harvard faculty dealt with an equally wide range of topics, including recent discoveries of the vertebrate paleontologists, current conceptions of the earth's interior, and the cosmologists' newest "hot universe" theory. Wallace R. Brode, Science Adviser to the Department of State, also spoke on "Science Reporting Problems."

*The Hartford* Times' *man, Whitney Jacobs (left), and Brenton Welling of* Business Week *had coffee with President Stratton.*

Organizations represented included The Associated Press, Berkshire *Eagle*, Boston *Advertiser*, Boston *Globe*, Boston *Herald*, Boston *Traveler*, Buffalo *News*, *Business Week*, Chicago *Sun-Times*, *Christian Science Monitor*, Columbia University, Denver *Post*, Detroit *Free Press*, Hartford *Times*, Louisville *Times*, National Science Foundation, Newburyport *Daily News*, New York *Herald Tribune*, New York *Times*, Newark *News*, Palo Alto *Times*, Philadelphia *Bulletin*, Providence *Journal*, Quincy *Patriot Ledger*, Rochester *Times Union*, Science Service, Scripps-Howard Newspapers, Syracuse *Herald-Journal*, *Time*, Toledo *Blade*, United Press International, *U.S. News and World Report*, Washington *Post*, Washington *Star*, Waterbury *Republican*, Watertown *Daily Times*, and Worcester *Gazette*.

## Fellowships at Woods Hole

■ Five of 11 Summer Student Fellowships awarded this spring by the Woods Hole Oceanographic Institution went to M.I.T. men. This Fellowship program, which is now in its 29th year, gives students an opportunity to pursue advanced studies in oceanography under the supervision of the Institution's staff. No degrees, credits, examinations, or grades are given, although a certificate of accomplishment may be issued.

"We consider the Fellowship program one of our most important activities and are proud that many men and women now engaged in scientific research once were our Fellows," said Paul M. Fye, the Woods Hole Institution's Director. "Oceanography is expanding rapidly. We need the brains and drive of present-day students to aid in our aims to describe, understand, and eventually predict natural occurrences so that man may learn to make full use of his environment rather than be ruled by it."

The Woods Hole Educational Policy Committee received 98 applications for Fellowships this year from students of biology, chemistry, physics, mathematics, hydrodynamics, meteorology, and geology in 22 schools in the United States, India, Japan, and Sweden.

The five M.I.T. men who are recipients of the Fellowships are John C. Gille, Edward J. Green, Robert A. Phinney, Lynn R. Sykes, and Thomas F. Webster.

## Alumni Support Housing Program

■ President Stratton announced in April that M.I.T. plans to begin construction this summer of dining room facilities for the Burton House dormitory. This decision was made possible by a pledge that a substantial part of this year's 1959 Alumni Fund will be devoted to furthering development of the long-range residential plans of the Institute.

From its founding in 1941, the Fund has had a special interest in the welfare of students. It has supported scholarships and made large contributions to several of the Institute's major building projects, including the Baker House dormitory.

As stated jointly by John J. Wilson, '29, President of the Alumni Association, and Edwin D. Ryer, '20, Chairman of the Alumni Fund Board: "The Executive Committee of the Alumni Association and the Alumni Fund Board have pledged a substantial portion of the uncommitted funds of this year's Alumni Fund to the betterment of residential life at the Institute. It is also the unanimous sentiment of the two groups that the continued improvement of student housing should be a major responsibility of the Alumni."

"Speaking both as President of the Institute and as an Alumnus," President Stratton said, "I can think of no more appropriate uses of the Alumni Fund than the support of undergraduate scholarships and the improvement of student residential and campus facilities. This generous pledge of the Fund Board will permit us to plan immediately to implement some of the recommendations of the Committee on Student Housing."

This committee was a group of Corporation members, Faculty, Alumni, and students who spent a year studying the Institute's long-range residential needs.

## New Knowledge of Hearing Sought

■ A unique laboratory in which doctors, neurophysiologists, and electrical engineers will work together has been established by the Massachusetts Eye and Ear Infirmary and M.I.T. This program of research, treatment, and education, it is hoped, will contribute to understanding the basic phenomena of hearing and help solve some problems of deafness.

The new laboratory was built and equipped at a cost of $200,000 and will be operated under grants from the National Institutes of Health. Located at the Infirmary in Boston, it is known as the Eaton-Peabody Laboratory of Auditory Physiology.

Work in the laboratory is directed by Dr. LeRoy A. Schall, Chief of Otolaryngology for the Infirmary and Lecompte Professor of Otology at the Harvard Medical School, and Walter A. Rosenblith, Professor of Communications Biophysics at M.I.T. The research is under the supervision of Dr. John W. Irwin, Director of the Microcirculatory Laboratory at the Infirmary, and of Dr. Nelson Yuan Sheng Kiang, neurophysiologist in M.I.T.'s Research Laboratory of Electronics.

There are two principal forms of deafness, according to Dr. Schall. One, conductive deafness, is that in which mechanical obstructions in the middle ear interfere with hearing. Surgeons have developed successful techniques for dealing with this form.

*Former students of Arthur C. Cope, Professor of Organic Chemistry at M.I.T., gave him two bound volumes of reprints of his articles, at a luncheon in the Statler Hilton Hotel in Boston during the 135th annual meeting of the American Chemical Society. At left is Elmer R. Trumbull, Jr., a postdoctoral fellow in the Department of Chemistry at the Institute in 1947-1948.*

The other principal kind of deafness is thought to involve faults in the initiation of the nerve impulses on their way to the brain. This is the defect that occurs often as the result of long exposure to loud noises and not infrequently as a complication of conductive deafness. It also is associated with the process of aging. To the extent that scientists do not fully understand the detailed ways in which these received changes take place in the inner ear, doctors can do little to correct defects in this area.

Using the techniques of electrical engineering as well as those of neurophysiology and psychophysics, Professor Rosenblith has conducted extensive studies in the Research Laboratory of Electronics at M.I.T. in an attempt to learn more about the part played by the nervous system in hearing.

Typically, auditory stimuli such as clicks are fed into the ears of subjects, either humans or animals. Electrical activity (such as brain waves) from the subjects is then analyzed by means of a computer to determine the extent to which the stimuli were actually recorded by the brain. Since such research deals often with tiny electrical currents that have to be detected in the presence of much other electrical activity, these experiments require great delicacy and precision.

To eliminate sounds and electrical signals not under study, the new laboratory at the Infirmary was constructed in a way that isolates it from much of the outside world. It is built on 40 piles driven into the blue clay below the filled land of Back Bay so that vibration of traffic will not reach it, and one room is lined with copper screen, to shut out radio waves and other electrical interference.

### On the Horizon

*June 15, 1959 —*

*Morning:* Inauguration of Julius Adams Stratton, '23, as the 11th President of the Institute.

*Afternoon and Evening:* 25th Alumni Day and the 84th Annual Alumni Banquet, with the Boston Pops Orchestra again on the M.I.T. Campus.

## Individuals Noteworthy

■ Named in the news recently were the 23 Alumni whose elections, promotions, and appointments are recorded below:

*Ralph A. Fletcher, '16,* as a Director, Union National Bank, Lowell, Mass. . . . *Irwin L. Moore, '20,* and *William Webster, '23,* respectively, as Chairman of the Board and as President, New England Electric System;

*Paul J. Cardinal, '24,* as a Director, New York Board of Trade, Inc. . . . *Ello E. Richardson, '25,* as Vice-president and General Manager, Cambridge Gas Company . . . *Robert W. Conly, '26,* as Senior Vice-president and Comptroller, Aetna Life Insurance Company, Aetna Casualty and Surety Company, and Standard Fire Insurance Company;

*J. Robert Bonnar, '27,* as Director of Marketing, Dyestuffs and Chemical Division, General Aniline and Film Corporation . . . *George I. Chatfield, '28,* as Senior Vice-president, Director, and member of the Plans Board, Benton and Bowles, Inc., New York City . . . *Charles T. Abbott, '30,* as a Director, New England Gas and Electric Association Service Corporation;

*Joseph R. Stevens, '30,* as President, J. T. Baker Chemical Company, Phillipsburg, N.J. . . . *Bennett Archambault, '32,* as Chairman, Stewart-Warner Corporation . . . *James J. Robson, '32,* as President, Tire and Rim Association, Inc.;

*Colonel Arthur L. MacKusick, '32,* as Commanding Officer, White Sands Missile Range, New Mexico . . . *George W. Ewald, '37,* as Manager, Synthetic Industrial Fabric Department, J. P. Stevens and Company, Inc. . . . *Karl P. Goodwin, '37,* as a Director, Massachusetts Blue Cross;

*Charles E. Reed, '37,* as General Manager, Metallurgical Products Department, General Electric Company, Detroit . . . *Edward A. Beaupre, '41,* as Assistant to the Vice-president — Operations, Sanders Associates, Inc., Nashua, N.H. . . . *J. Lester Klein, '41,* as Vice-president, Nuclear Metals, Inc., Concord, Mass.;

*Thayer Rudd, '41,* as Plant Manager, Allegheny Electronic Chemicals Company, Bradford, Pa. . . . *Edward O. Vetter, '42,* as Executive Vice-president, Metals and Controls Corporation, Attleboro, Mass. . . . *Robert D. Peck, '44,* as Chairman and General Manager, Asbestos Construction Company, New York City;

*Leonard C. Maier, Jr., '48,* as Vice-president of Marketing for Defense Products, Crosley Division, Avco Manufacturing Corporation . . . *Raymond F. Rogers, '48,* as Treasurer, Polymer Corporation, Reading, Pa.

■ Special honors and awards announced recently for Alumni and members of the Faculty include:

To *Abbott L. Johnson, 2d, '22,* dedication of the airport of Muncie, Ind., as Johnson Field, by Vice-president Richard M. Nixon . . . to *Raymond P. Harold, '23,* the 10th Isaiah Thomas Award, by the Advertising Club of Worcester, Mass.;

To *James R. Killian, Jr., '26,* the Washington Award, by the Western Society of Engineers . . . to *Robert B. Semple, '32,* its 1959 Prize, by the Commercial Chemical Development Association;

To *Professors Edwin R. Gilliland, '33,* and *John C. Sheehan,* its $1,000 awards for achievements, respectively, in industrial and engineering chemistry, and for synthesizing penicillin and research in the synthesis of peptides, by the American Chemical Society . . . to *Richard H. Harris, '48,* designation as one of 10 "outstanding young men of Greater Worcester," by the Junior Chamber of Commerce, Worcester, Mass.;

To *Captain Richard C. Wingerson, '52,* the Mervin E. Gross Award, "given to the student in each class for the most outstanding performance and contribution through his resident tour," by the Air Force Institute of Technology.

## The Atomic Patterns of Crystals

■ Among the National Science Foundation's 1,006 grants totaling $45,572,385 in one quarter of the government's fiscal year 1959 was one for $63,500 to M.I.T. There also were others, of course, for work being done at the Institute, but this one was of special interest because it was for a project directed by Martin J. Buerger, '24, Institute Professor and recent recipient of the Roebling Medal of the Mineralogical Society of America. Under his guidance, four young scientists are embarking on a three-year, intensive study of eight lesser-known minerals. They will look into the structures and properties of crystals.

At least a year is needed, says Dr. Buerger, to determine the arrangement of the atoms in a solid substance by means of x-ray diffraction. One can find the distances between the atoms readily by this method, but discovering their arrangement is difficult. Only since 1946 has it appeared possible to solve the pattern-analysis problem by direct means.

"This problem is rather like that of an engineer who has before him all of the parts of a complicated steel-arch bridge, but no directions for fitting them together," Dr. Buerger explains. "At M.I.T. we have devised a method of 'image-seeking functions,' which employs a mathematical device to sort the distances between the atoms so that the atoms fall into the proper places in the pattern. But this system has definite limits at present and is only applicable to crystals of moderate complication. The atomic structure of highly complex crystals such as proteins is still unsolvable."

His associates are Charles T. Prewitt and Bernhardt J. Wuensch of this country, Tibor Z. Zoltai, from Canada, and Roberto Poljak, from Argentina.

## M.I.T. Fiesta In Mexico

■ On March 12-14, the 11th Annual Fiesta of the M.I.T. Club of Mexico, founded in 1910 as the earliest of the present 26 foreign M.I.T. Clubs, was favored by a record total of 56 visitors from the United States, Panama, and Peru, including as special guests of honor John J. Wilson, '29, President of the Alumni Association, and Sra. Wilson.

The program opened on Thursday, the 12th, with an assembly for cocktails at the Hotel Vasco de Quiroga, after which the ladies were escorted for luncheon at the home of Salvador Madero, Jr., '29. Meanwhile, the Alumni remained for luncheon at the Vasco, as pictured adjacently.

On Friday evening there was a cocktail buffet held on the 41st and 42d floors of the Latino-Americana skyscraper; on Saturday evening came the traditional *Noche Mexicana*, held in the spacious gardens of the home of Clarence M. Cornish, '24, the Club's President. Special color was lent to this occasion by many local members and ladies who wore costumes typical of various regions of Mexico.

**Top of page:** *John J. Wilson, '29, President of the Alumni Association, is in the center of this* Noche Mexicana *group in the garden of the home of Clarence M. Cornish, '24, President, M.I.T. Club of Mexico. In white, behind him, is Sra. Wilson.* **At right:** *Charles E. Smith, '00, who was the 41st President of the Alumni Association; Lieutenant General Emilio Madero, '02; and Clarence M. Cornish, '24, (at right).*
**Below:** *At the head table for the opening alumni luncheon were (from left to right): J. A. Lunn, '17, 57th President of the Alumni Association; M. S. Vallarta, '21, former President of the M.I.T. Club of Mexico; Lieutenant General Madero, '02; J. J. Wilson, '29; C. M. Cornish, '24; H. E. Lobdell, '17, Executive Vice-president, Alumni Association; C. E. Smith, '00, 41st President, Alumni Association; S. Madero, Jr., '29; and A. M. Valdés, '25, Treasurer of the M.I.T. Club of Mexico. In front of Dr. Vallarta is Cecil H. Green, '23, of Dallas, Texas.*

## Paul Weeks Litchfield: 1875-1959

■ Paul Weeks Litchfield, '96, dean of America's rubber industry and honorary chairman of the Board of the Goodyear Tire and Rubber Company, died on March 18 in Phoenix, Ariz. He was the M.I.T. Alumni Association's 36th President and twice served as an alumni term member of the M.I.T. Corporation, in 1918-1923 and in 1926-1931.

Mr. Litchfield was born in Boston in 1875 and attended Boston public schools. While a student at M.I.T., he investigated the possibilities of 28 industries and concluded that rubber was probably the most promising. When graduated, he accepted a $9-a-week job with a firm manufacturing bicycle tires in Reading, Mass. In 1900, he went to Akron, Ohio, to join the

**Paul Weeks Litchfield, '96**

two-year-old Goodyear Company which later became the world's largest tire builder and rubber manufacturer.

Mr. Litchfield played a leading role in the company's world-wide expansion. Starting as superintendent of all production, development and engineering, he became factory manager in 1911, a vice-president in 1915, president in 1926, and chairman of the Board in 1930. Mr. Litchfield relinquished his responsibilities as chief executive officer of the company in 1956, but continued to serve as chairman of the Board and a member of various management committees until he retired in October, 1958.

His many notable accomplishments included the establishment of a Goodyear development department, which made such outstanding contributions to the tire industry as the first straight-side tire, the first cord tire, and the first pneumatic cord truck tire. He became interested in aeronautics before World War I and was for many years one of the world's leading advocates of lighter-than-air ships for commercial and military use. The aeronautics department which he formed at Goodyear produced hundreds of military observation balloons, the dirigibles U.S.S. *Akron* and *Macon*, and the stratosphere balloon which set an altitude record in 1935. During World War II, he played a major part in the synthetic rubber program and Goodyear Aircraft became one of the 10 largest producers of aircraft.

He received many awards, both domestic and foreign, and wrote extensively on business subjects. His books included *Autumn Leaves* (1945), describing a general philosophy of life; *The Industrial Republic* (1946), which set forth his views of employee relations, and *Industrial Voyage* (1954), an oft-quoted autobiography. His community honored him at a testimonial dinner last winter before he left Akron for his winter home in Litchfield Park, Ariz.

Mr. Litchfield is survived by his wife and two daughters, Mrs. Howard L. Hyde of Akron, and Mrs. A. Wallace Denny of New Toronto, Ontario.

## The Alumni Council's Meeting

■ What is the engineer's place in business management? John B. Rae, Associate Professor of History, explored this question at the March 23 meeting of the M.I.T. Alumni Council and found that the movement of engineers into management has been persistent, substantial, and increasing in volume.

Although there has been little perceptible relationship in some instances between a man's engineering training and his work afterwards, the influx of engineers into management has been too great to be ascribed to chance or coincidence, Professor Rae noted. The steady rise in the proportion of engineers gravitating to management, he believes, may be taken as an indication that they have proved reasonably successful in executive roles, even though it does not tell us in what ways their technological training contributed to this result.

The Council also received a report from D. Hugh Darden, Executive Secretary of the M.I.T. Educational Council. There are 735 of these counselors now and last year they interviewed nearly 3,300 applicants for admission to the Institute. Seventy per cent of last September's entering class of 921 had been interviewed by a counselor.

William L. Taggart, Jr., '27, chairman of the Alumni Day Committee, announced plans for the inauguration of Julius A. Stratton, '23, as the Institute's 11th President on June 15. The Alumni Day luncheon, reception, and banquet will follow, and the Boston Pops Orchestra will play that evening in Kresge Auditorium under the direction of Arthur Fiedler. Mr. Taggart proposed and the Council elected 19 persons to three committees. Wolcott A. Hokanson will head the Registration Committee; Albert O. Wilson, Jr., '38, will be chairman of the Luncheon Committee; and Philip H. Peters, '37, will be chairman of the Banquet and Entertainment Committee.

Edwin D. Ryer, '20, chairman of the Alumni Fund Board, reported that 10,764 Alumni had given a total of $416,232 during the preceding nine months, and predicted that this will be the Alumni Fund's best year by a significant margin.

Donald R. Stevens, President of the Class of 1911, presented resolutions occasioned by the death of Orville B. Denison, '11, and the Council accepted them by a silent standing vote.

John J. Wilson, '29, President of the Alumni Association, presided and Donald P. Severance, '38, presented the secretary's report.

(*Continued on page 366*)

# Interplanetary Flight Propulsion Systems

**Professor George P. Sutton lists some requirements and assesses the suitability of exciting proposals**

**A TECHNOLOGY REVIEW REPORT**

***Across the top of the cover of this issue of The Review is a list of the methods of propulsion for interplanetary flight that were considered recently by Professor George P. Sutton. Down the column on the left is a list of interplanetary flight maneuvers that he considered. The circles indicate his view of the suitability, acceptability, and undesirability of these eight proposed means of propulsion for each of seven different maneuvers in space.***

THE engines used for interplanetary flights in the future will be quite different from those used in ballistic missiles today. The maneuvers necessary to take instruments, cargoes, and men from planet to planet differ greatly in the demands that they impose on a propulsion system. The range of prospective missions is tremendous.

What will be required of the engines? What new problems will their designers face? For which missions are the various proposed new methods of propulsion most suitable? How will these new kinds of engines be developed and tested?

Professor George P. Sutton took up such stupendous questions as these in the fourth Minta Martin Lecture at M.I.T. this spring. Professor Sutton considered three kinds of missions: Those confined to the immediate vicinity of the earth and moon; those to planets no farther from the sun than Mars; and those to the outer part of the solar system beyond Mars. For trips to the moon and other satellites of the earth, a high acceleration rate such as one obtains with a chemical propulsion system is desirable. For trips to planets in the inner part of the solar system, less acceleration will result in sufficiently high velocities, and more methods of propulsion become interesting. For the still longer journeys to planets out beyond Mars, even very low acceleration rates will give acceptable velocities when applied for months or years. For these very long journeys, he believes, electrical propulsion systems now seem to be "uniquely qualified."

*Professor Sutton came to M.I.T. from the Rocketdyne Division of North American Aviation, Inc., last fall as Jerome C. Hunsaker Professor of Aeronautical Engineering. He will leave the Institute shortly to become Chief Scientist for the Advanced Projects Research Agency of the U.S. Department of Defense. His views of the problems and engines of the future are both fascinating and worthy of every citizen's attention.*

### The Engines

*Chemical* rockets, he noted, are well developed and understood. All of the satellites have been hoisted into their orbits by chemical propulsion. Many different types and forms of chemical rockets have been explored and built. Their performance will be improved by the use of such high-energy chemicals as fluorine, hydrogen, and boron compounds, but the energy that can be derived from chemical combustion is limited.

Nuclear rockets still are in the exploratory or research stage. A nuclear fusion process would be attractive, but a prolonged fusion reaction has not yet been achieved. Meanwhile, there are two possibilities: A system in which heat is generated by a fission reaction; and one in which energy from the decay of radioactive isotopes is used.

*Fission* of uranium might provide the energy to heat the gases ejected by a rocket basically quite similar to the chemical, liquid-propellant rockets. A working fluid such as hydrogen might be gasified, raised to a high temperature by a nuclear reactor, expanded through a supersonic nozzle, and accelerated to very high velocities. The strength of materials at high temperatures, however, now limits the performance of nuclear rockets. Even flanges and bolts in the hardware adjacent to a reactor and rocket would have to be cooled to remain strong. Since there is no air in space, the radiation would not be scattered. Shadow shields could protect men and sensitive equipment, but are difficult to design. Co-ordinating nuclear activity and the flow of gases also looks difficult.

*Isotope decay* might provide the energy for a relatively simple propulsion system. If the right isotope is chosen, nearly all of the decay energy can be transferred to a working fluid, but such isotopes will be costly, the energy obtainable from them will diminish as time passes, and shielding against their radioactivity will be needed both at the launching site and in the

vehicle. Professor Sutton does not expect a nuclear device to fly soon.

An electrical propulsion system will be attractive when a light, compact nuclear reactor is developed. The specific impulse, or thrust derived from each pound of propellant per second, can be increased from 15 to 150 times by using an electrical system, and three different kinds of electrical systems are being considered.

*Arc heating* is one possibility. Electrical energy might be added to a working fluid within an arc struck between two electrodes. This arc could create a plasma, or electrically neutral fluid containing both positive ions and negative electrons, to be ejected.

*Magneto-plasma* is the name given to a second electrical propulsion proposal. In such a system, the plasma might be accelerated by changing magnetic fields, or by the interaction of an electric current and a steady magnetic field.

*Ion* propulsion is a third electrical possibility, and seems preferable because of its relative efficiency, simplicity, and prospects for prolonged operation. In such a system, electrons would be stripped from atoms by bringing dis-similar materials together. The resulting positive ions then would be accelerated in an electrostatic field and discharged at very high velocities. At the same time, the electrons previously stripped from the ions would be emitted, so that the ions could reabsorb them and be neutralized.

"Although considerable work is going on in all these and related fields," Professor Sutton said of the electrical propulsion proposals, "the effort is still largely exploratory. The technical problems are not only associated with the propulsive device but also with the power source and efficient conversion and control mechanism."

*Solar-heating* propulsion would call for an optical device to be pointed at the sun, so that a working fluid could be heated by its radiation. The energy available would depend on where you were; such a system would not function within the shadow of a planet, and at Pluto's distance from the sun you would receive only about 3.5 per cent as much radiation as you did in the earth's orbit. Small solar-heating rockets may be practical soon, but folding or furling a big optical system poses substantial design problems.

*Solar sailing* is applicable only in the general direction away from the sun. There can be no "tacking" as is customary with ships sailing against the wind. But solar sailing is attractive for some maneuvers; a ship, for example, might be turned around in a few hours by the pressure of light on reflectors extended from the vehicle on long arms.

### The Maneuvers

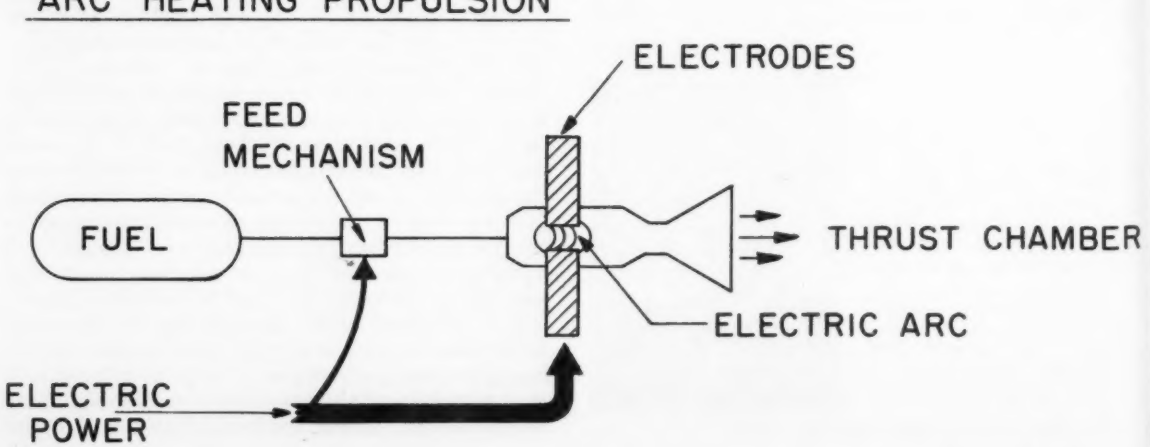
The velocity increments needed to execute the various maneuvers that will be necessary in an interplanetary flight will differ greatly. The vehicle must not only reach an orbit around the earth, like that of a satellite, but have sufficient velocity to *escape from orbit*. The acceleration (or ratio of thrust to weight) desired to do this will be high, and can be obtained best with chemical or nuclear propulsion. One's getaway would be much slower with an isotope-decay, electrical, or solar system.

Next, the interplanetary traveler will need sufficient energy to get into an orbit around the planet that he wishes to reach. In this *interplanetary transfer* maneuver he must overcome the sun's gravitational field and correct for differences in the tangential velocities of the planets between which he is traveling. His time of departure and scheduled arrival time affect this propulsive demand.

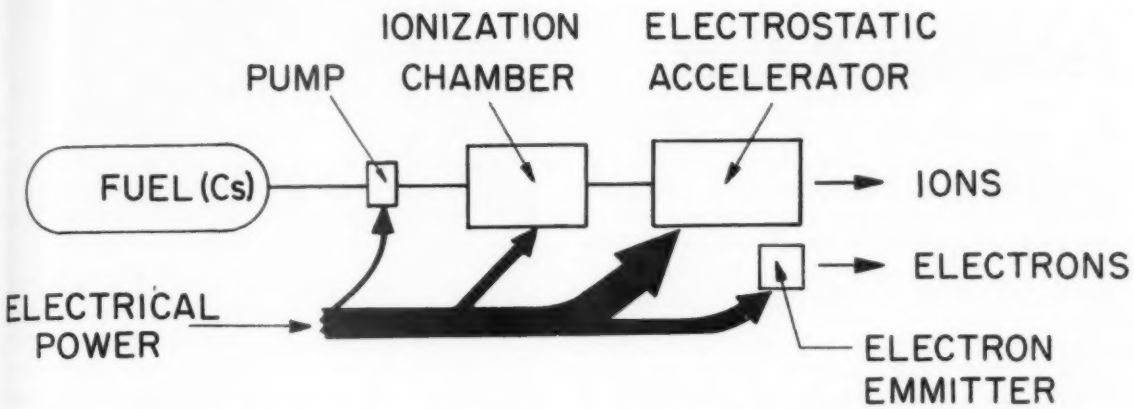
Since the orbits of the planets are not in a single plane – Mars, for example, moves in a plane inclined 1.85 degrees to that of the earth – provision also must be made for a *change of plane*. The energy required for this will vary considerably, depending on the relative positions of the launching and target planets.

Some energy will be needed, too, for *vehicle orientation*, or adjustment in the pitch, yaw, and roll to orient the spaceship in a specified direction, but a simple auxiliary system may suffice for this. *Trajectory corrections* also will be necessary to compensate for errors in the map of the solar system and in navigation and guidance, but these probably can be made slowly.

The *target approach*, or adjustment of the velocity of the ship to match that of the planet which is to be its destination, may call either for acceleration or deceleration. If one relies on a low thrust-to-weight ratio engine, this maneuver will have to be started some



## ION PROPULSION




distance away from one's destination. With a high-acceleration engine, it can be begun later.

The *capture* maneuver will bring the vehicle into an orbit around the planet it is headed for, and will call for relatively large forces. The final landing from this orbit also will require high thrust. Here, as at the take-off, the chemical and fission propulsion systems appear to be most suitable.

"The low thrust-to-weight ratio engines are particularly suited for interplanetary transfers, and the higher thrust engines for operation in a fairly strong gravitational field," Professor Sutton pointed out. "This means that different engines will be used for different maneuvers.

"If, for example, it is desired to send an exploratory probe to become a satellite of Jupiter, it would be reasonable to have one or two chemical or nuclear rockets for earth escape, an electrical system for the transfer orbit and its corrections, the same electrical rocket stage for an approach to Jupiter and the vehicle's capture into a satellite orbit (perhaps even a separate chemical rocket to augment this maneuver), the same electrical rocket for the escape from Jupiter and the return interplanetary transfer, and even some of the slowing-down maneuver, and finally perhaps another chemical rocket for the capture maneuver into a decreasing orbit about the earth."

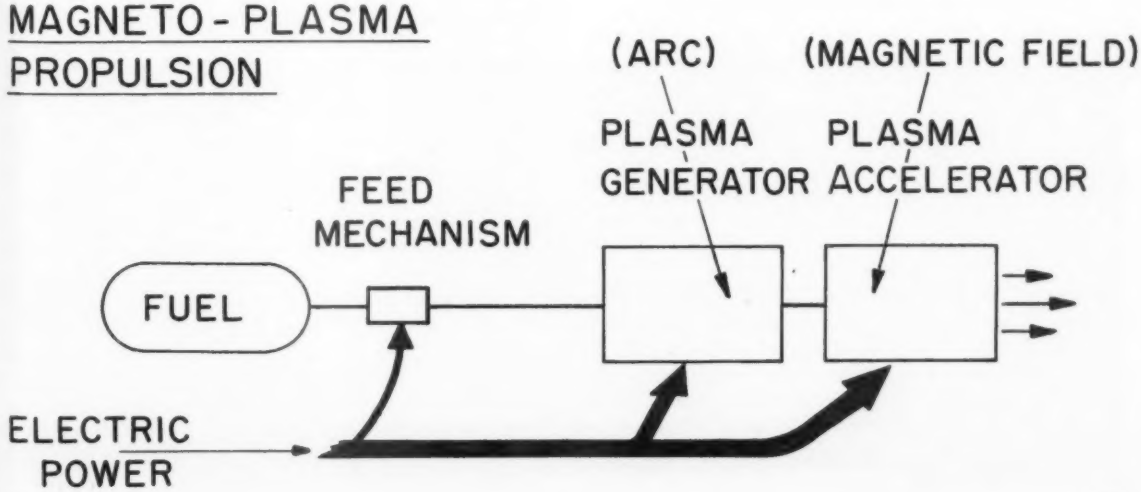
### The Strange Environment

The environmental conditions in which the engines of interplanetary vehicles must operate are not too well understood, but some of the difficulties can be foreseen. Prolonged exposure to a high vacuum could cause some materials, such as are now used in soldering, simply to disappear, and might affect the strength of other materials. During much of an interplanetary journey, gravity will be zero within the vehicle, and this will affect the separation of vapors from liquids, the emptying of tanks, and the operation of switches and valves. The thermal equilibrium of the engine will be affected by the design of the vehicle, and its builders will face unusual problems of dissipating heat.

The space engines, moreover, will be subjected to various kinds of radiation and the impact of meteorites and meteoroids. Hence, it may be fortuitous, Professor Sutton remarked, that heavy structures are needed with certain types of propulsion systems. The heavy tanks of thrust chambers required for chemical sys-

(*Concluded on page 380*)

## MAGNETO-PLASMA PROPULSION



# Today's Technology Matrons

**Usefulness, as portrayed in the Furniture Exchange below, is keynote for Matrons although sociability continues to prevail**

**by ELOISE M. SMITH**

THE distaff side of the Institute has undergone a metamorphosis as surely as has the Institute itself. In my father-in-law's day* Boston Tech was a small college. The Faculty wives met socially for tea. This social pattern prevailed for a long time. Now the Technology Matrons have left the social butterfly stage and moved into a new stage: service to the Institute, especially to students.

One reason for this change, a gradual one to be sure, is that the small college has given way to a medium-sized university. The former group of Faculty wives is now an organization of about 2,000 women whose husbands have the equivalent of staff status at M.I.T.: 716 wives of teachers; 140 wives of administrative, medical, and athletic department staffs; 333 wives of Lincoln Laboratory staff; 446 wives of Instrumentation and other defense laboratory staffs; 186 women staff members; and 120 Honorary Matrons, most of whom are wives of retired professors, or widows.

Without Matrons' meetings, the wife of a professor might never meet wives of men in research or the

*The home-furnishings exchange in action.*

Administration. Sociability serves a purpose, but it is not the prime purpose of the Technology Matrons today. Usefulness is.

We undertake no project unless it is needed, wanted, and can be done by no one else at the Institute. The idea is then cleared with the Administration. It may come close to the sphere of influence of a dean, or a department head; if so, he, and others, are consulted.

The most recent project is an example. There seemed to be a need for low-cost house furnishings for students, especially married and foreign students. After exploring the idea of setting up a Student Furniture Exchange, the Administration made available an empty apartment in Westgate West (wartime barracks since demolished). A dean's wife volunteered to head up the project and appealed to the M.I.T. community for cast-off furniture. She and the Matrons assisting as volunteers were inundated, yet within a few months they appealed for more furniture – such was the student response. Thousands of pieces of furniture have moved into and out of the Furniture Exchange. Late in the spring, furniture will be bought back; six months later, the supply will again be depleted. The Furniture Exchange is at 224 Albany St., Cambridge.

Another project is assisting with the visit of the Red Cross Bloodmobile to M.I.T. The students, employees, staff, and so on, support this four-day visit so generously that it requires 32 Matrons to provide nontechnical assistance. Other matrons assist at the Homberg Infirmary, especially during epidemics, and continuously with the mending for the Infirmary.

One of the most successful projects is the entertaining of foreign students who number over 700. We want these visitors to acquire a friendly, realistic attitude toward American family life. Faculty members are especially interested in this Matrons' project and they usually entertain their own students. Lincoln Laboratory families enjoy meeting foreign students, too, and do more entertaining each year, especially for Freshmen.

Another Matrons' service, not duplicated on any other campus so far as we know, is helping married foreign students find housing. A letter is sent to their homes before they leave for the U.S.A., offering this service. If they wish, they are met at the point of arrival in Greater Boston. Temporary quarters are found and then a Matron drives them to look at vacant houses and apartments. They are assisted, if they wish, with shopping and other practical domestic know-how.

Later in the fall a group of Matrons invites the foreign wives to supper. Much of their timidity is gone by then, and they usually ask many questions, especially about medical services.

How are these, and many other, useful projects financed? Wholly by contributions from the Matrons themselves. The Matrons also receive about $500 a year from the fund left to them by Mrs. Forris J. Moore, widow of a professor of chemistry, who asked that it be used for "teas and other expenses."

The Institute contributes toward the cost of *The Bulletin*, which is sent out six or more times each academic year. *The Bulletin* is sent to wives of Corporation members and to wives of all men at M.I.T. with staff status. Each *Bulletin* gives the details of a forthcoming Matrons meeting, and of the interest groups. These are: Book Review Club, Bridge Club, Choral Group, Community Players, Evening Group, and a small Sailing Group. Interest has even been expressed in a Matrons Investment Club.

There are no dues. Financial support is not a prerequisite for being a Technology Matron, just one's husband's M.I.T. association (past or present), and a strong sense of loyalty to the Institute.

* The late Professor Emeritus Robert H. Smith, 1886-1932, Mechanical Engineering.

by ELBERT P. LITTLE

**Thousands of American students already are studying science in new ways with new aids, and more teachers will introduce them soon**

# The New High School Physics Course

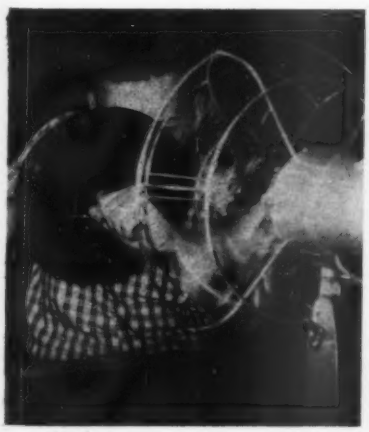
IN 270 secondary schools, 12,500 students now have passed the mid-point in a new physics course developed by the Physical Science Study Committee which was formed at M.I.T. in the fall of 1956. The course will be revised, in the light of reports from teachers now using it, and introduced in more schools next year. By the fall of 1960, the committee hopes, materials will be ready for widespread distribution, many more teachers will have been familiarized with it, and many students will be finding science more rewarding.

The materials being developed include a new textbook, new laboratory apparatus and manuals, teaching films, guides for teachers, and a series of books for supplementary reading. The pictures on this and the next three pages include illustrations from the text, show examples of the laboratory apparatus, and give one a few glimpses of the work now well under way.

The course begins with an introduction to physics, physicists, and the tools of physics. A general study of the nature of time, space, motion, and matter fol-

Above: *Professor Jerrold R. Zacharias studies his script during a pause in production of physics teaching films in the Watertown, Mass., studio of the committee that he heads.*

Below: (Left) *A student uses a slotted-disk stroboscope to "stop" an electric fan.* (Right) *He will also use microbalances, made of soda straws, sewing needles, and microscope slides.*



Above: *A split-image range finder is used to see how triangulation is employed to measure distances.*

Left: *A strobe photo of a bouncing ball shows the student the correspondence between reflection of a particle and the optical phenomenon of reflection of light from flat surfaces.*

Below: *The optical reflector at left shows that curved reflectors can be thought of as formed from many small, flat reflectors. To study phenomena associated with wave reflection from flat and curved surfaces, students are using ripple tanks. Water-wave patterns generated in glass-bottomed tanks are projected on paper screens (as at the right).*

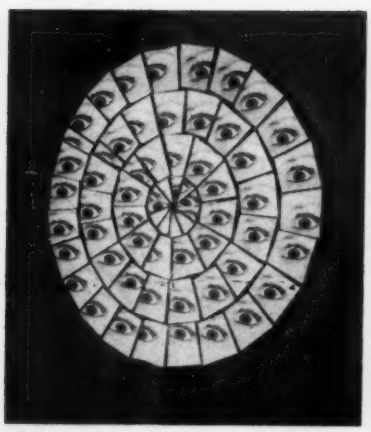
lows, and measurement and mathematics are presented as the analytical tools of physics.

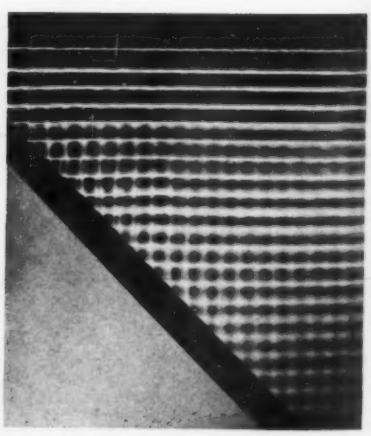
Light is studied in the second quarter. Optical phenomena are examined, the particle and wave models of light are considered, and a high point comes when the student finds it necessary to reject the particle model on the basis of his own observation.

In the third part of the course, he studies mechanics, with the emphasis on Newton's law of motion and the conservation of momentum and energy.

Modern atomic physics is reached in the last quarter. Electric and magnetic forces lead into the study of atomic structure. Then, while examining such phenomena as the photoelectric effect and electron diffraction, the student comes to the break with classical physics where light is seen to have particle characteristics and matter exhibits wave properties.

The committee's objective has been not merely to strengthen existing courses with teaching films and other supplementary learning aids, but to devise a

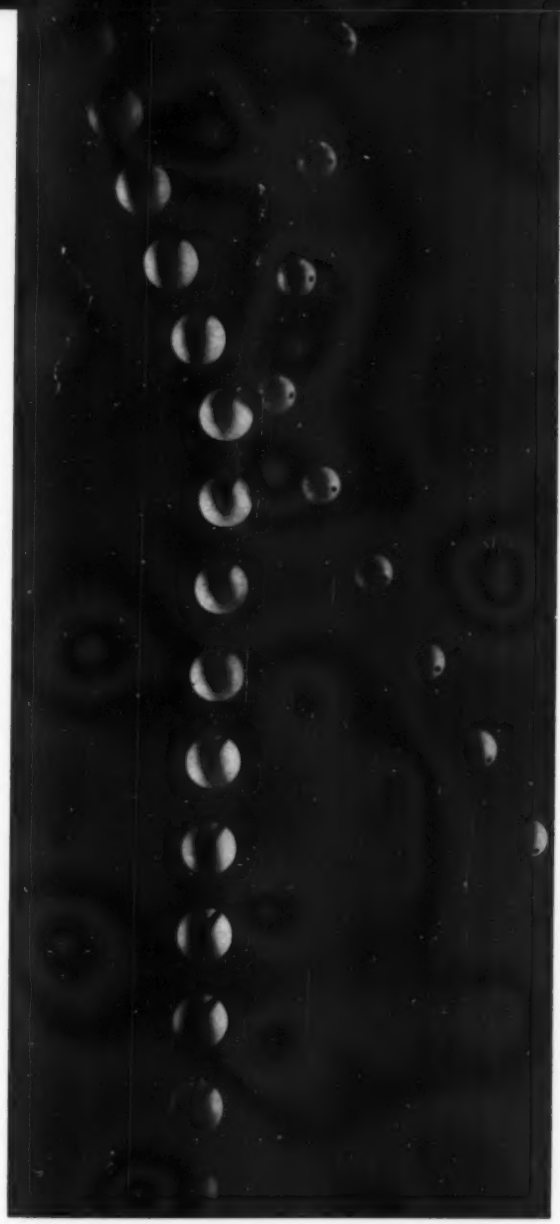




Above: *Concepts of acceleration are developed by applying a force to a roller-skate cart loaded with bricks.*

Right: *Conservation of momentum is illustrated by a strobe photo of a collision between balls that differ in mass.*

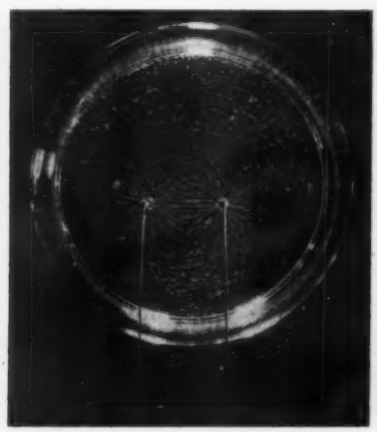
Below: *A coffee can containing an aluminum-coated soda straw pivoted on a needle becomes an electroscope. The seeds suspended in a liquid interface* (in center) *line up around oppositely charged electrodes. The simple current balance* (at the right) *is used by students to determine the magnetic field strength within a solenoid coil.*

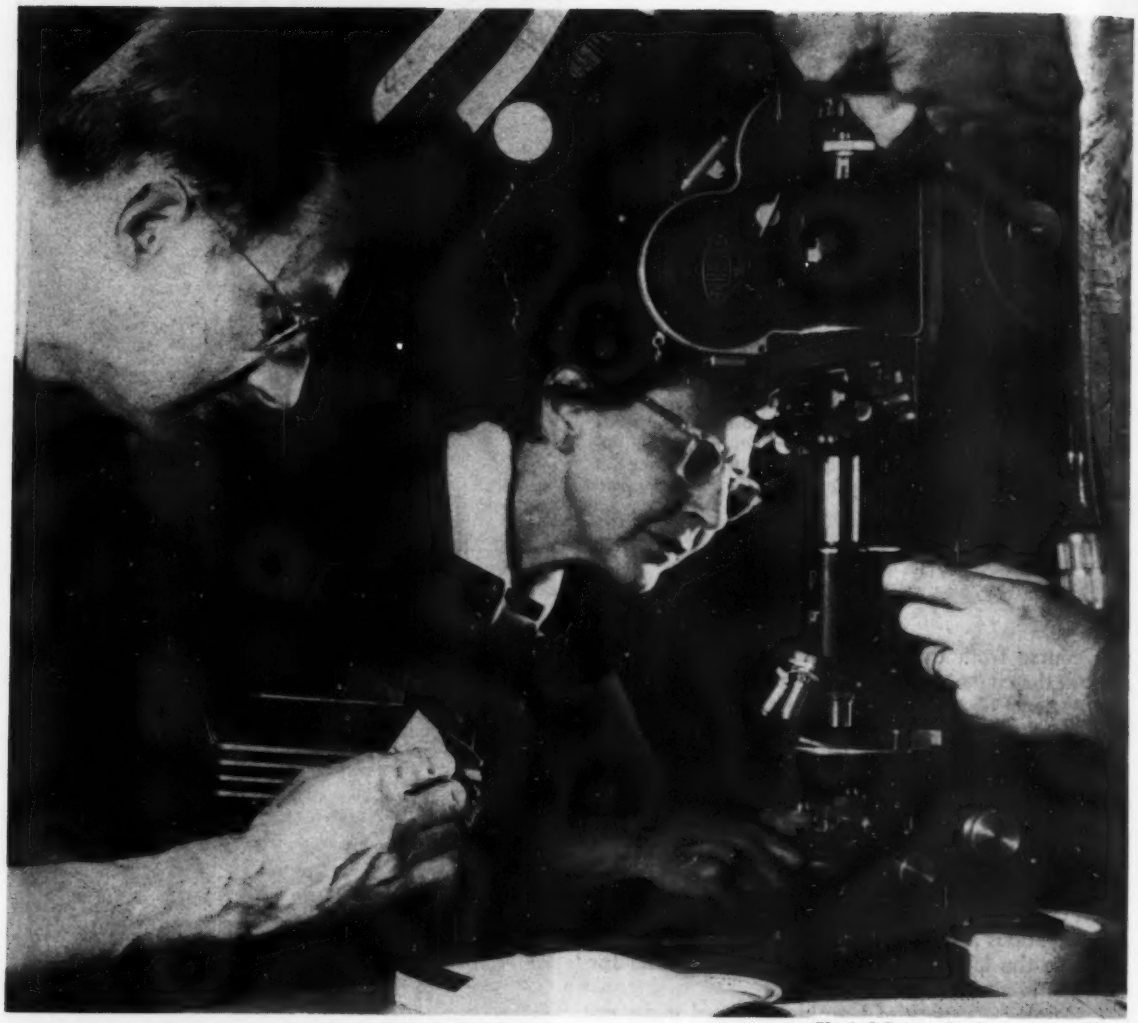


new course from the ground up. Such a course is needed, the committee found, in order to:

1. Present physics as an integrated subject, emphasizing its great unifying concepts;
2. Include the important innovations in physics of the last quarter century;
3. Introduce physics as a cultural stimulus, and show physicists as real people;
4. Impart appreciation of the evolution of physics, past and present;
5. Follow a phenomenological approach, with laws and definitions arising from observation and analysis;
6. Use the laboratory for learning rather than for exercises in verification;
7. Employ a variety of learning aids and make extensive use of modern audio-visual techniques; and
8. Meet the needs of students having a broad range of talents, interests, and career plans.

In addition to developing learning aids, the committee has inaugurated a teacher-familiarization pro-

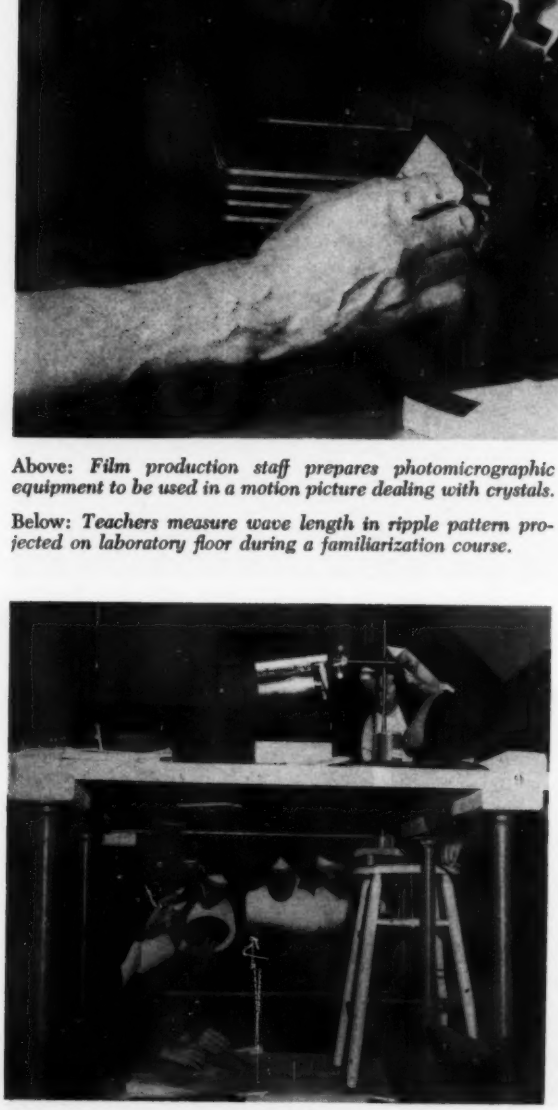




*Physical Science Study Committee Photos*

Above: *Film production staff prepares photomicrographic equipment to be used in a motion picture dealing with crystals.*

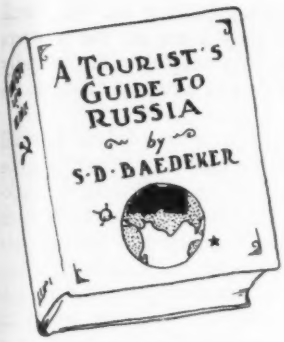
Below: *Teachers measure wave length in ripple pattern projected on laboratory floor during a familiarization course.*



gram in co-operation with the National Science Foundation and several sponsoring colleges and universities. Five institutes were conducted last summer, 15 will convene this summer, and other teachers are attending evening and Saturday morning courses now in more than a dozen in-service institutes.

The small group of scientists and educational leaders who formed the Physical Science Study Committee in the office of Jerrold R. Zacharias, Professor of Physics at M.I.T., has grown into a large organization. More than 250 college physicists, high school teachers, industrial scientists, and technical specialists have helped plan and create the new course.

M.I.T. administered the study for two years and financial support was derived from the National Science Foundation, the Fund for the Advancement of Education, the Alfred P. Sloan Foundation, and other private sources. Now a new nonprofit corporation, known as Educational Services, Incorporated, has taken over administration of the significant program.




# If You're Going to Russia . . .

**You'll find some customs strange, and others familiar, this guide for tourists points out**

*These nuggets of advice, arranged alphabetically, for visitors to the U.S.S.R., have been provided by an Assistant Professor of Russian at M.I.T., who was there on a cultural mission last fall. His purpose was twofold: To clarify similarities and differences between the U.S. and the U.S.S.R.; and to assist professional men who plan to visit Russia this year if cultural contacts continue.*

by **SECOR D. BROWNE**

**ARRIVAL:** Immediately upon arrival in the U.S.S.R. your passport will be taken and you will be held in a waiting room for about a half hour until it is returned. You will be required then to fill in a currency declaration listing cash and travelers' checks in your possession.

You are not permitted to carry Soviet currency into the U.S.S.R. or take Soviet currency out with you. Be sure to keep the duplicate of your currency declaration because you may be required to surrender it when you leave the U.S.S.R.

Your luggage probably will not be inspected and you may or may not be required to sign a customs declaration. The speed and ease of formalities depends in large measure on who you are, in Soviet estimation, and by whom, if anybody, you are met. At worst, however, the formalities are slow rather than onerous.

**AIR TRAVEL:** Flights to, from, and in the U.S.S.R. can be arranged through your travel agent or local air line office. Once in the U.S.S.R., you must reconfirm your air schedule or make any changes through the Intourist Office in your hotel. Reconfirmation is a lengthy process and Intourist may keep your ticket two or three days. Changes in schedule are not easily or rapidly made and are to be avoided, particularly if they involve continuing travel by foreign carrier.

Intourist provides ground transportation to and from the airport and will get you there in plenty of time. You probably will not be notified of any delay or cancellation of your flight until some time after your arrival at the airport, and even then information as to what will happen next and when, is hard to obtain, likely to be conflicting, and always subject to revision without notice. It is advisable to follow the example of Soviet travelers and relax in a heap with your belongings until something happens.

**CABLES:** There are two classes of service: straight, or delayed. A straight cable usually will be delivered overnight. A delayed cable is considerably cheaper but may take two or three days.

To avoid error and delay, it is advisable to print the message in block letters. The more conscientious clerks will try to talk you out of (in their opinion) superfluous words and expressions such as "love."

**CHURCHES:** Most churches of historic interest are maintained only as museums. St. Isaak Cathedral in Leningrad is an antireligious museum. Russian Orthodox services are held in some churches in Moscow, Leningrad, and elsewhere. Roman Catholic mass is said on Sundays in a building of the Moscow headquarters of the Ministry of the Interior (MVD) and in a Roman Catholic church in Leningrad. Protestant and Jewish services are held in both Moscow and Leningrad. The Intourist Office in your hotel will advise you of the hours of services and provide transportation.

**CURRENCY:** Foreign currency can be exchanged and travelers' checks cashed at banks, or more conveniently, at the exchange desk found at the airport and in most hotels. The official exchange rate is four rubles to the dollar but the tourist rate given the visitor is 10 rubles to the dollar. At the time of exchange you will be given a receipt stating the amount of rubles received. These receipts should be kept for currency clearance when you leave the U.S.S.R. The rubles which you still have at the time of your departure

can be exchanged for a draft in dollars which can be cashed through your bank after you return to the U.S.

There is a black market in the U.S.S.R. in foreign currency, clothes, cigarettes, and so on. You may be approached by young men who wish to practice their English. Shortly thereafter they may wish to practice changing rubles for dollars at 30 or 50 to one, or rubles for shirts, shoes, suits, cigarettes, or other items. They may have ikons or other works of art to offer. Since there are very few things which you are likely to wish to purchase, you have no real need for their cash rubles. As for ikons and *objets d'art*, it is nearly 42 years since the Revolution, and the quality and genuineness of such articles offered now is at least questionable. Moreover, it is possible that the young men are representatives of the MVD, and you might not enjoy being bailed out by the U.S. Embassy and asked to leave the U.S.S.R.

**DRINKS:** There are no bars, saloons, or cocktail lounges. Spirits (vodka, brandy), beer, and wines are served in restaurants and can be purchased in bottles in grocery stores or at your hotel.

**FORMS OF ADDRESS:** The visitor will be addressed as "Mister," "Doctor," or "Professor," as appropriate. The hotel staff will often use "Gospodeen." Soviet hosts whom you have met in the United States may address you by your first name. Soviet citizens usually address each other by the first name and patronymic: Ivan Ivanovich; rarely, and then only collectively or formally as "Comrade" (Tovarishch), or "Citizen" (Grazhdanin).

**GUIDES:** Your hotel Intourist Office will assign you a guide-interpreter for the term of your stay. The guide ordinarily works from 9:30 A.M. to 6:00 P.M. six days a week and if needed, a substitute interpreter will be assigned on your regular person's day off.

The majority of the interpreters are girls, graduates of the Institute of Foreign Languages, with an excellent command of the language. They are very well trained and you will find they know all the answers and most of the questions. Generally they are friendly and co-operative and, in terms of museum mileage, inexhaustible.

Even if you speak Russian, you are advised to avail yourself of the services of the guide-interpreters since they are well briefed in approved historical background and information and in many cases, such as visiting the Kremlin, they short-circuit the queues awaiting admission. When you are with an interpreter-guide, it is also usually not necessary to pay for admission to museums. If invited, they may agree to accompany you, outside regular line of duty, to a restaurant or theater. Guides do not accept tips but, if one has been especially interested and helpful, some small gift is not out of order. Such a gift can be a booklet of views of your part of the U.S., a tie, or a lighter – perhaps for the guide's father or husband inasmuch as few women in the U.S.S.R. are smokers.

**HOTELS:** Upon arrival, you will be assigned by Intourist to one of their hotels. Such usual hotel functions as the arrangement of transportation, tours, sight-seeing, limousine service, theater and amusement tickets, guides and information are carried out by the Intourist Office, which also furnishes booklets of meal tickets (coupons, "talony") for use in the hotel and other Intourist restaurants.

At the hotel desk you will find an administrator (manager) who will assign your room upon arrival and clear you when you depart. Each floor of the hotel is controlled by a dezhurnaya (floor clerk) who keeps your room key, mail, and messages, arranges for laundry, pressing, and so on.

Size and decor of the rooms depend somewhat on whether the hotel is pre- or post-Revolution. The furnishings in either case tend to be ornate and massive with heavy brocades and tassels. Heat and hot water are generally adequate in the larger cities, not so in smaller places. There is a tendency for water closets to run continuously. Plugs for wash basins are universally absent and you are advised to take along a large diameter flat rubber kitchen sink stopper.

The rooms and linen are clean. You may view the system of bedmaking with a quizzical eye since the bedclothes are neatly folded but not tucked under the mattress. Unless you are inclined to sleep wrapped up like the late Chief Sitting Bull, you will be faced with nightly bed remaking. Room service is slow and elaborate but adequate.

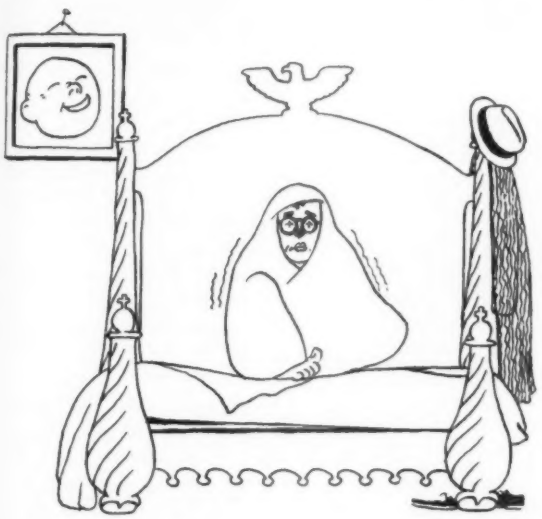
Laundry takes, on the average, three days and is satisfactory. If you have "drip-dry" clothes, don't forget an adequate supply of detergent, miniature clothespins, and an elastic clothesline. In older hotels with some 14-foot ceilings and hookless bathrooms, installation of your clothesline may be an interesting exercise in engineering ingenuity. Pressing service is satisfactory. Dry-cleaning is not recommended. Laundry and dry-cleaning is on a semi-C.O.D. basis via the "dezhurnaya." Room service is paid for with meal tickets (coupons, "talony") or cash at the time of delivery.

Elevator service is extraordinarily slow. You will be fortunate in an older hotel if assigned to the lower

floors so that you can use the stairs. A travel alarm clock is a good idea since the request "wake me at 8:00," can get lost in the language and be interpreted by the staff either overzealously or not at all.

The hotel grill or restaurant will open at 8:00 or 9:00 A.M. in the morning. The menu is in five languages: Russian, English, French, German, and Chinese. Service, by U. S. standards, is extraordinarily slow.

The hotel will have a newsstand, gift counter, and post office-telegraph desk in the lobby. The newsstand provides postcards, magazines, newspapers, and books. In Moscow and Leningrad the assortment includes some English language editions of Soviet publications. The gift counter offers souvenirs which, if they appeal to you, you might as well buy there since the price for any article will be the same everywhere. The post office-telegraph desk sells stamps, stamped envelopes, and stamped picture postcards in addition to accepting telegrams and cables.



**INTOURIST:** The Soviet state tourist agency is said to have once been a branch of the MVD. Intourist's official full name now is the Union-Wide Stock Society. Intourist is responsible for the transportation, lodging, meals, tours, guides, interpreters, amusements, and security of visitors to the U.S.S.R. Prior to arriving at a U.S.S.R. port or airport of entry, an Intourist voucher usually has been obtained and paid for through a travel agency or an Intourist Office abroad.

Official guests of the Soviet government (for example, scientists invited to a conference or meeting sponsored by the U.S.S.R. Academy of Sciences) have all or part of the cost of the visit defrayed by the U.S.S.R., depending on the importance to the Soviets of the individual's visit.

Intourist takes the voucher upon the visitor's arrival in the U.S.S.R. (usually at the Intourist Office in the first hotel to which he is taken), and issues meal tickets for him. The visitor's passport is also taken at this time, to be returned three or more days later, after it has been registered with the local office of the MVD.

(*Continued on page 378*)

# The Contrasts in Russia Fascinate an Alumnus

**by ELLIOTT B. ROBERTS, '21**

VISITING the Soviet Union as a delegate to the recent International Geophysical Year conference, I met leading scientists, visited research institutions, and roamed the streets of Moscow and other cities. It was a revealing experience – depressing, it is true, but what I saw fascinated me mightily. Strange contrasts were on every hand, all serving to illuminate the vigor of Soviet industry.

My hotel and six other towering palaces reach skyward in rococo grandeur from dismal jungles of dilapidated tenements and log houses. The plaster flakes off and bricks fall out of still-unfinished apartment buildings in the 600,000-unit housing projects outside Moscow, yet clocks everywhere, even in busses and taxicabs, are precisely on time – there is no deviationism among Moscow timepieces! Neckties are nonexistent, and unkempt loungers fill the hotel lobby, yet no one will commit the indecency of licking a postage stamp. The largest atom-smasher in the world, a proton synchrotron rated at 10 billion electron volts, is working not far from Moscow, while the hotel cashier and the store clerk compute your change on the archaic abacus, because the factories are too busy to make cash registers. The subway runs smoothly, carrying its daily load of 2,500,000 workers from unbelievably squalid homes, who pass through 40 resplendent stations decorated with marble panels, statuary, oil paintings, and crystal chandeliers. Heavy trucks rumble through the dark streets by the hotel. Welders' sparks fall day and night from a massive new bridge, growing across the Moscow River.

Some of the streets and squares must be the widest in the world – veritable parade grounds! They are certainly the cleanest, with old women poking at every scrap of litter with twig brooms, and woe to the cigarette-dropper seen by a sharp-eyed policeman! With no speed limit in the streets, pedestrian crossings provide breath-taking contests with rugged trucks, well-worn busses, and handsome trackless trolleys. Black, curtained limousines, dashing madly through the traffic, can sometimes be seen screeching to a halt to save harming unruffled flocks of street pigeons. The few private automobiles used by writers, scientists, ballet dancers, and other privileged members of the classless society, are Russian copies of the sensible American small cars of a decade ago. The sidewalks swarm at all hours with workers en route to their jobs or walking to escape the confinement of their cell-like apartments.

These cheerless people seldom dare more than a furtive glance at a foreigner, except the small boys who offer souvenir pins and beg for chewing gum, but will accept no coins. Stolid and impassive, they drift along in shapeless and ugly clothes, or stand in the inevitable queues to purchase food and cheap articles of living. There are no luxuries. Style and color are eagerly sought by the women, but quality is not to be found. Knots of wistful women collect

(*Concluded on page 376*)

# The Remarkable "Maser" Story

**This new kind of amplifier helped contact Venus and will make more exciting news**

**by Benjamin Lax and Harry C. Gatos**

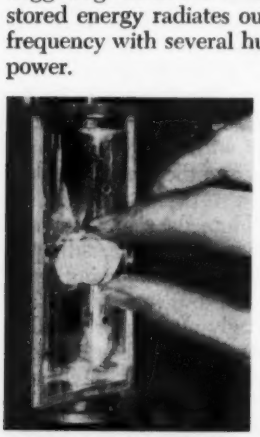
*Benjamin Lax, '49, has provided dynamic leadership of Lincoln Laboratory's solid-state research program for more than seven years and is now head of the recently organized Solid State Division at the Laboratory. Harry C. Gatos, '50, Associate Head of the Division, is also leader of the Solid State Chemistry and Metallurgy Group which developed the maser materials.*

*The maser operated at a temperature close to absolute zero.*

A SOLID-STATE "maser" amplifier was the final link in the chain of technological developments which enabled the M.I.T. Lincoln Laboratory's radar apparatus to contact Venus. Because of its importance in this experiment, and because this was the first time a solid-state maser was used for any purpose other than research on the maser itself, this is an appropriate time to review its origins and implications.

An amplifier is a device which causes an input signal to be increased in strength. An auxiliary source of power is required, of course, to make the signal put out by the amplifier more powerful than the signal put in. In this sense, the maser is no different from the vacuum tube and the transistor.

The name "maser" (like "radar," for "*ra*dio *d*etection *a*nd *r*anging") is an acronym for "*m*icrowave *a*mplification by *s*imulated *e*mission of *r*adiation," a phrase which is descriptive of the physical process by which the maser produces amplification of electrical signals at microwave frequencies. The heart of the solid-state maser is a single crystal of carefully controlled composition, which stores energy pumped into it from an auxiliary power source. In response to the triggering action of a microwave input signal, the stored energy radiates out of the crystal at the signal frequency with several hundred times the signal input power.



*This was the crystal.*

The ultra-high-frequency maser used in Lincoln's Venus experiment was developed during the summer of 1957 by Robert H. Kingston, '47. The principle of the device had been demonstrated in a gas maser at Columbia University in 1951. Exploitation in a solid-state maser of properties peculiar to certain crystalline materials at very low temperatures had been proposed at Harvard in 1956. Lincoln scientists were in the vanguard of several research groups that succeeded, almost simultaneously, in reducing the solid-state maser to practice and in building working models for experimental use.

The input signal amplified when Venus was reached was in the vicinity of 440 megacycles per second, the lowest frequency at which a solid-state maser had been operated. The crystal was potassium cobalticyanide containing a small but essential amount of paramagnetic impurity (chromium ions). The signal was coupled into the crystal and the amplified signal was picked off by means of the tuned wire loop which supported the crystal. The auxiliary power source pumped energy into the crystal at 5400 megacycles per second via the cylindrical cavity in which the crystal was mounted.

To achieve the desired performance with such an amplifier, the whole assembly (with the cavity closed) is operated in a bath of liquid helium, at a temperature 1.25 degrees Kelvin above absolute zero. The low temperature reduces the disturbing effects of thermal vibrations of the crystal lattice, with two important results:

1. It makes possible the storage of microwave energy in the crystal;

2. It makes the crystal electrically quiescent, so that the extraneous electrical noise generated within the crystal is very small.

It is this latter property that makes the maser so valuable for amplification of very weak signals. Laboratory measurements have shown that the noise from a maser is at least 100 times less than that from a conventional amplifier. The primary limitations on noise in a maser system are set by the associated circuitry rather than by the maser itself.

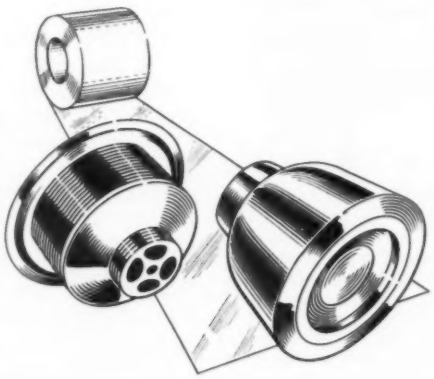
The maser used when Venus was contacted cannot be isolated from other facets of solid-state research

*(Concluded on page 374)*

# BUSINESS IN MOTION

## *To our Colleagues in American Business . . .*

Although miles apart in their functions the door knob and sink strainer shown below have one thing in common. Both are made from Revere Brass Strip. Revere Leaded Brass Strip was used to make the sink strainer because of the ease with which large diameter threads are machined, the excellent surface it develops for chrome plating, the inherent corrosion resistance of brass and its drawing characteristics (strainer had to be drawn from .065″ gauge x 7″ strip to a 2½″ depth).



The Revere Brass Strip used by the manufacturer of seamless, one-piece door knobs possessed still other characteristics that made it the most desirable for that specific purpose. Because of the unique procedure by which these knobs are made the brass has to be able to stand up under some mighty rugged going. Further, the brass strip has to be of uniform gauge and be without any sign of fracture or crimping when drawn, as well as have consistently correct grain structure to insure a smooth, flaw-free surface on the finished knobs without extensive finishing and polishing operations.

These are but two of the literally thousands of ways Revere Brass Strip makes it possible for manufacturers to offer *their* customers a superior product at the lowest possible cost.

The combination of unusual properties makes Revere Brass Strip, in various anneals and tempers, equally suited to stamping and spinning. Manufacturers have found that the high ductility and malleability of various Revere Brass Alloys effect savings in time and cost because deeper draws in one operation are possible. And, because of the low, work-hardening rate, a combination of forming processes is frequently possible in making intricate shapes without the need for intermediate annealing. Should annealing be required the temperatures used are low (usually not over 1100° F.) which means lower fuel cost.

Revere Brass Strip not only permits deep draws, but fast draw speeds as well, which is particularly desirable for repetition press work or other operations where parts are produced in large quantities. This means relatively low power consumption.

Revere Brass Strip does not foul dies quickly, requiring only a minimum of die re-dressing. And one of its most desirable features is that it plates well and polishes easily, requiring only a minimum of finishing.

Revere Brass Strip in its various alloys is still another example of how, by fitting the metal to the job, it is possible to produce superior products at the lowest possible cost.

Practically every industry you can name is able to cite similar instances. So we suggest that no matter what your suppliers ship you, it would be a good idea to take them into your confidence and see if you cannot make a better product at lower costs by specifying exactly the *right* materials.

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*Founded by Paul Revere in 1801*
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stepped-up
DEMANDS

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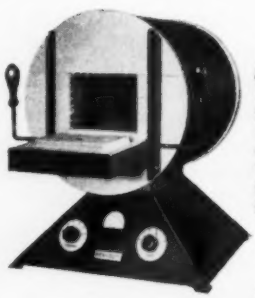
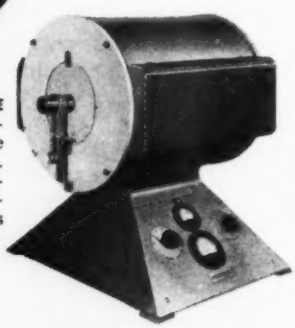


MUFFLE FURNACE—"Multiple-Unit" Muffle furnaces have a maximum temperature of 1850°F. Temperature indicating and controlling devices are located in the pyramid base for full protection and visibility.

HIGH TEMPERATURE TUBE FURNACE — Temperatures to 2600°F. can be reached in this furnace. Other Hevi-Duty laboratory furnaces have maximum temperatures as high as 3000°F.



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Harold E. Koch, '22, *President*
Elton E. Staples, '26, *Vice President*
Chester Meyer, '36, *Assistant Secretary*

# TALK OF OUR TIMES

## The Chemists and World Security

*How can chemists and chemical engineers contribute to the establishment of a viable world for mankind? Walter G. Whitman, '17, Head of the Department of Chemical Engineering, took up this question at a meeting of the American Chemical Society in Boston last month. Professor Whitman said in part:*

■ The introduction of this thesis is a series of four premises which are unpalatable but, I believe, rather inescapable:

1. Man's power to destroy has so multiplied that another major war would eliminate modern civilization.

2. The only safeguard against such destruction which the peoples of the powerful nations now recognize is an ability to retaliate in kind. This "balance of terror" is inherently unstable.

3. The atomic monopoly of today – held by the United States, the Soviets, and Britain – will soon be broken. It is logical to expect that 15 nations will have the bomb within a dozen years if governments regard it as a No. 1 priority objective.

4. The world will become still more unstable as this occurs. Atomic weapons are well suited to the purposes of the blackmailer and of the desperate dictator.

This prospective degeneration of world security challenges each of us to study the causes of our predicament and to search for constructive actions which might turn the scales. . . .

The opportunities which are unique to us as professional people lie in the area of human relationships with individual chemists and chemical engineers of the Eastern nations. Some of you have such personal relationships. I have been especially privileged because of my United Nations work in the preparation and operation of the first Atoms-for-Peace Conference at Geneva in 1955. . . . If the pathway to direct communication seems thorny today, we can gather encouragement by remembering that only four years ago the Iron Curtain was an impregnable barrier, patrolled by both sides. . . .

Why do we chemists and chemical engineers have special responsibilities to develop personal understandings with people of the Soviet Union? We are perhaps no better nor any wiser than other citizens. However, the nature of our skills is such that both governments believe that it is in their interests to allow some personal contact. Importantly, we are members of a profession in which the individual can fairly anticipate that a fellow professional, regardless of nationality, will greet him with respect and an open hand.

The effectiveness of such contacts is of course a very personal matter with the participants, as in all human relations. Suspicion or cynicism, even if one attempts to conceal it, will elicit similar attitudes. The early introduction of political topics will almost certainly be disastrous – each party will be impelled to defend his system and to attack the others. An attitude of frankness with the other man – of a sincere interest in learning from him – is the sound approach.

*(Concluded on page 364)*

# COMMAND DESTRUCT

The flight testing of second generation missiles—more versatile and powerful than their predecessors—requires a device for sure termination of any missile flight that might endanger the test range or surrounding area.

Ramo-Wooldridge engineers, under a United States Army Signal Corps contract, have successfully developed and delivered the first sub-miniature, completely transistorized radio "command destruct" receivers.

Specifically designed for missile flight safety operations, the receiver (AN/DRW-11) can actuate safety mechanisms or destruct devices. It has three command channels, each of which actuates a control relay.

The "command destruct" receiver accepts frequency modulated signals in the UHF radio command control band. It is designed to operate with closer radio frequency and command frequency channel spacing than has been used to date, thus making possible more efficient use of the available radio spectrum.

Compact and rugged, the radio receiver's modular construction permits rapid and complete accessibility to all components. One module houses the basic receiver. The second module contains the three command channels and relays. This integrated package occupies 115 cubic inches, and weighs 4 pounds. The receiver requires no pressurization and operates reliably under the adverse environmental conditions encountered in missile flight testing.

Engineers and scientists interested in being associated with some of the nation's most advanced research and development programs are invited to acquaint themselves with current opportunities at Ramo-Wooldridge. The areas of activity listed below are those in which R-W is now engaged and in which openings exist.

**Missile electronics systems**
**Advanced radio and wireline communications**
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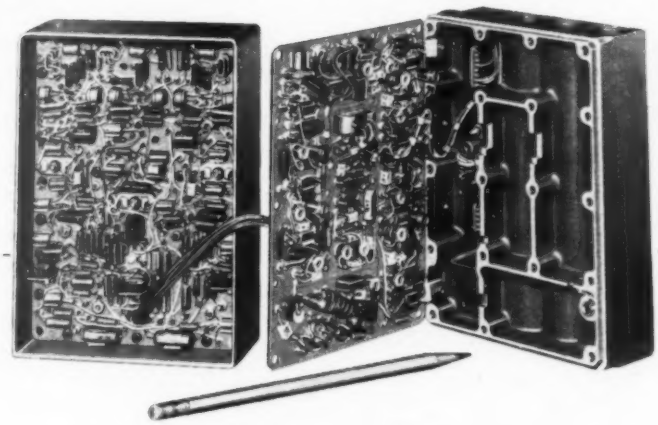
**Air navigation and traffic control**
**Analog and digital computers**
**Infrared systems**
**Electronic reconnaissance and countermeasures**
**Basic and applied physical research**

For a copy of our brochure, *An Introduction to Ramo-Wooldridge,* or other additional information write to Mr. Donald L. Pyke.



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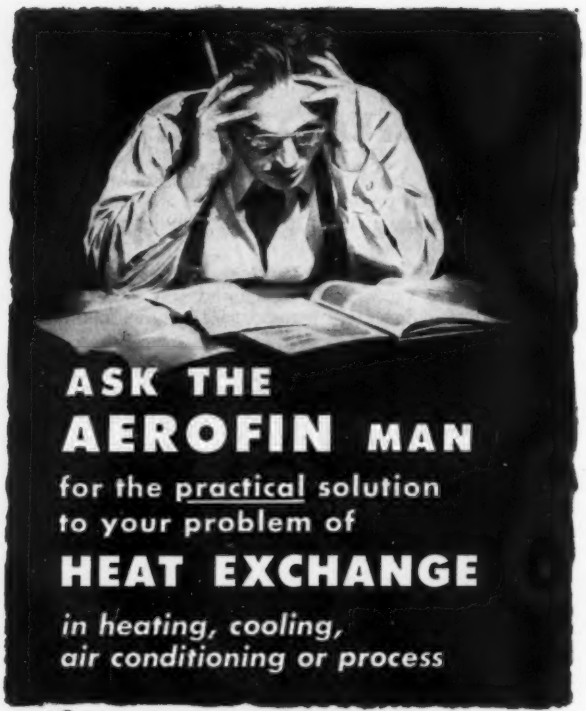
a division of ***Thompson Ramo Wooldridge Inc.***

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Pioneers in Light-Weight, Extended Surface

## TALK OF OUR TIMES

(*Concluded from page 362*)

The physicists have been more advanced in furthering these contacts than we have been to date. They were, of course, more prominent in creating the Atomic Age and therefore quicker to sense its revolutionary effects on international relations. Governments are perhaps predisposed to accept theoretical physics as supranational. However, the recent Soviet emphasis on chemistry as the means for raising their living standards may be expected to increase our opportunities for contact in the future.

Does this crusade for individual understandings seem pitifully weak when measured against the antagonisms of the Cold War and the power of the bomb? Indeed, it does. Yet it represents a *positive* force in a welter of negatives – a force which by affecting the attitudes of individuals may initiate chain reactions in the thinking of whole peoples. . . . Today we see the Soviets in a more rational light as a result of Atoms-for-Peace conferences, mutual visits of orchestras, ballets, and theater groups, and the many joint activities of the International Geophysical Year.

Our efforts to build understanding and confidence may be like the grain of mustard seed in the parable: "which indeed is the least of all seeds: but when it is grown, it is the greatest among herbs, and becometh a tree. . . ."

NEW HORIZONS . . .
AND HIGHER ALTITUDES
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solves many problems due to the constantly rising temperature requirements of missiles. While the inorganic insulation is fibrous in form it is however protected to some degree from the absorption of moisture under humid conditions. Decomposition due to heat aging leaves no deleterious carbon deposit.

Flexibility — these cables can be bent or twisted without damage following exposure to high temperature.

Cables withstand 1000° F through the use of oxygen-free nickel-clad copper conductors.

Where abrasion is a factor, BIW 1000° F cables may be shielded with stainless steel or nickel-clad copper braid.

send for information.

1000° F FLEXIBLE INSTRUMENT WIRE

Small diameter light weight cables. Voltages are usually not over 120 volts AC and the cables are rated at 300 volts.

| | OD | | OD |
|---|---|---|---|
| #24 gauge | 0.100" | #20 gauge shielded | 0.135" |
| #24 gauge shielded | 0.125" | #16 gauge | 0.135" |
| #20 gauge | 0.110" | #16 gauge shielded | 0.160" |

1000° F FLEXIBLE POWER CABLES

Ample insulation provides additional dielectric strength and mechanical protection. Voltage rated at 600 AC.

| | OD | | OD |
|---|---|---|---|
| #20 gauge | 0.150" | #16 gauge shielded | 0.185" |
| #20 gauge shielded | 0.175" | #12 gauge | 0.200" |
| #16 gauge | 0.160" | #12 gauge shielded | 0.225" |

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# Defense Weapon

The telephone is a defense weapon —and an important one.

A manufacturer of rockets, for example, needs data or delivery on a specific part. He picks up his telephone, makes several Long Distance calls, and his problem is solved.

An unidentified aircraft is detected in flight by a radar installation. The information is relayed automatically and instantly over telephone cables to a defense center.

It is then flashed over the network of special Bell System telephone lines which link the country's entire system of continental defense.

The role of the Bell System does not stop there or with the thousands upon thousands of calls that are a part of the manufacture of countless items of defense.

Its Bell Telephone Laboratories are engaged in many important research and development projects for the government. These include the Nike Zeus anti-missile missile system and the guidance system for the Titan intercontinental ballistic missile.

Western Electric, the Bell System's manufacturing and supply unit, is producing the guidance and control equipment which is the heart and brains of the mighty Nike Ajax and Nike Hercules missile systems.

The Sandia Corporation, a subsidiary of Western Electric, continues to manage the Atomic Energy Commission's Sandia Laboratory, which develops, designs and tests atomic weapons.

Among many other Western Electric defense projects were the 3000-mile Distant Early Warning (DEW) Line in the Arctic and the "White Alice" communication system linking population centers and military installations in Alaska. Both were completed on schedule and turned over to the Air Force.

Another project for the Air Force was the design, production and supervision of installation of a communications system for a guided missile test range extending out to sea.

The backbone of this system is the special underseas cable that stretches 1370 nautical miles from Cape Canaveral in Florida to Puerto Rico. It provides an instant, secret, weatherproof means of transmitting data on missiles in flight.

Radar installations along the way spot the missile's flight position which is flashed continuously to the testing base by cable. So are signals from the missile itself.

Recently the U.S. Air Force asked us to add the communications phases of a ballistic missile early warning system to the other military projects handled by the Bell System.

The Bell System is primarily engaged in providing telephone service. But it gives top priority and its utmost effort to the needs of Government whenever it is called upon for work for which it is specially fitted by size and experience.

Particularly when it comes to protecting the country, it's good to use the best scientific knowledge available in the communications field.

**BELL TELEPHONE SYSTEM**

## TREND OF AFFAIRS

*(Continued from page 348)*

### Helping Students Arrange Trips

■ For about a year now, a large map of the United States has hung on a wall in the office of the M.I.T. Dean of Residence. This map has 60 pegs on it, placed strategically at various points across the United States, north into Canada, and south into Mexico. Any hopeful automobile rider willing to share trip expenses simply leaves a note on the peg nearest his desired destination. On the note he states his preferred times of departure and return, his precise destination, and, of course, his campus address. The next move is up to drivers who want riders. They either check the map occasionally or leave notes of their own. In this convenient fashion, as many as 200 people have been accommodated during various vacation periods. The service is supervised during the academic year by a member of Alpha Phi Omega, an unusual group itself.

The M.I.T. chapter of Alpha Phi Omega was founded in 1936, disbanded during the war years, and reorganized in 1948. All of its members have, at one time or another, been affiliated with the Boy Scouts. Presently the group consists of about 70 students. Among projects that they have worked on are an undergraduate telephone directory, a career book for seniors, a swimming instruction course for Cambridge scouts, and a charities carnival.

### More Sloan Fellows

■ Forty-five young men, the largest number in the history of the Sloan Fellowship Executive Development Program, will come to the M.I.T. School of Industrial Management next month. These men were nominated for fellowships by their employers, and will spend a year at the Institute studying fundamentals that underlie sound management decisions. Sloan Fellowships rank among the highest honors that can come to a young business executive.

Companies represented by this group include the Aerojet-General Corp., Allis-Chalmers Manufacturing Co., American Gas and Electric Service Corp., American Smelting and Refining Co., American Telephone and Telegraph Co., Atchison, Topeka and Santa Fe Railway Co., Avien, Inc., Binod Mills Co., Ltd., Campbell Soup Co., Central Illinois Public Service Co., Chrysler Corp., Columbia Broadcasting System, Continental Oil Co., Darin and Armstrong, Inc., Delta Steel Mill, Eastman Kodak Co., General Dynamics Corp., General Motors Corp., Hughes Aircraft Co., International Business Machines Corp., International Telephone and Telegraph Corp., Kennecott Copper Corp., Lever Brothers Co., Midland-Ross Corp., Radio Corporation of America, Seabrook Transmission Co., Singer Manufacturing Co., Southwestern Electric Power Co., Sun Oil Co., United Aircraft Corp., United Shoe Machinery Corp., United States Steel Corp., Wagner Castings Co., and Westinghouse Electric Corp., plus the United States Air Force and Navy.

*(Continued on page 368)*

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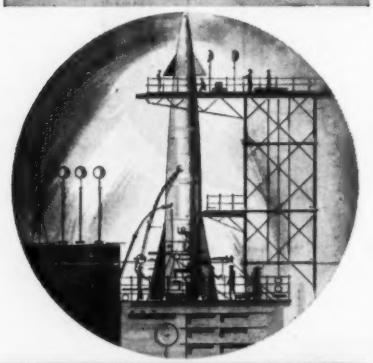

The Model 415 flow rate is 10 GPM for 1000 psi drop across the valve. Because of unique jet construction, particles as large as 200 microns can be passed through both the first and second stages without malfunctioning.

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## TREND OF AFFAIRS

(*Continued from page 366*)

### 50,000 Strong

■ Its annual census, taken as of March 31, disclosed a total of 63,596 names on the membership rolls of the Alumni Association: 50,023, or 78.7 per cent, being carried in living status, and 13,573, or 21.3 per cent, as deceased.

Four per cent of the living Alumni – that is, a total of 2,011 – were 50 or more years out of the Institute; 23 per cent were 31 to 50 years out; 41 per cent were 11 to 30 years out; and the remaining 32 per cent were out 10 years or less.

The *eldest fifth* of the living alumni body – that is, the group of 10,005 longest out of the Institute – included members of all classes from 1881 through 1923, plus 70 per cent of 1924. The *eldest quarter* further included the rest of 1924, all of 1925, and all but 30 per cent of 1926.

The *median point* of the 50,023 living Alumni fell nine-tenths of the way down the roster of the Class of 1942.

Four-fifths of the Class of 1951 down through 1958 composed the *youngest quarter;* and two-thirds of 1952 down through 1959 made up the *youngest fifth.*

### A New Medical Research Program

■ A training program for clinical scientists in cardiovascular and pulmonary research was announced last month by M.I.T. and the New England Center Hospital. Two trainees will be admitted to this program each year for the next three years. They will take a prescribed series of courses in advanced mathematics, physical chemistry, instrumentation, and other applicable subjects at M.I.T. for one year, then do more graduate work at the Institute during the next two years while engaged in special postgraduate studies and work at the hospital.

Irwin W. Sizer, Head of the Department of Biology, regards the program as an excellent example of the type of contribution M.I.T. can make to medicine at the postgraduate level, and hopes this kind of program will continue and expand. The National Heart Institute of the National Institutes of Health has made a $146,000 grant for this program.

(*Continued on page 370*)

**William H. Coburn & Co.**
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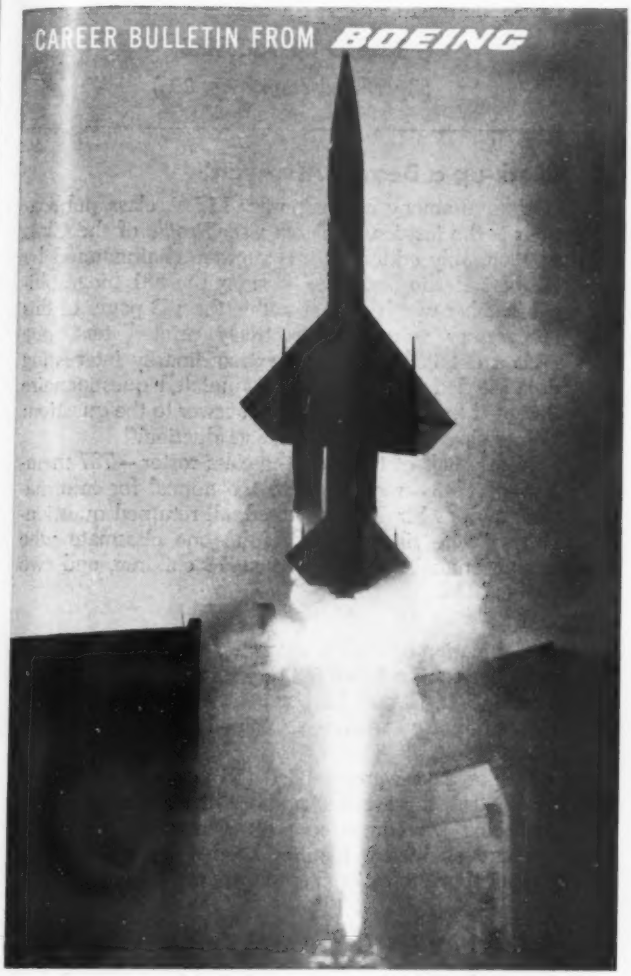
CAREER BULLETIN FROM **BOEING**



**BLAST-OFF** of supersonic Boeing BOMARC, the nation's longest-range defense missile. Now in volume production for Air Force bases under construction. Other Boeing missile projects that offer engineers and scientists outstanding career opportunities include Minuteman, an advanced solid-propellant intercontinental ballistic missile system.

**SPACE-AGE** projects are expanding at Boeing. Above is human factors laboratory in which problems of providing environments and controls for space vehicle crews are investigated. Celestial mechanics, lunar orbital systems and interplanetary systems are other areas that offer long-range space-age career opportunities to qualified engineers and scientists.

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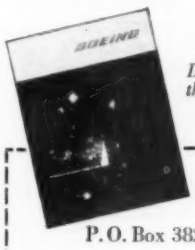


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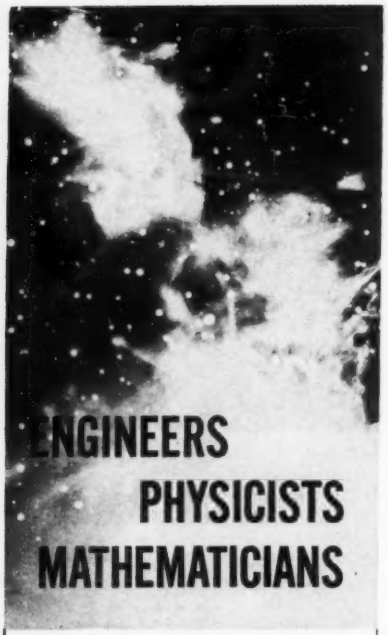


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## TREND OF AFFAIRS

(*Continued from page 368*)

### Check-up a Decade Afterward

■ Unique among contemporary M.I.T. class publications is the just-issued *Tenth Year Profile* of the Class of 1948, ably edited by a committee chairmanned by Herbert S. Kindler.* For, besides the 881 biographical sketches which appear within the 173 pages of this anniversary volume's attractively printed text, one finds a detailed analysis of extraordinarily interesting data yielded by a carefully formulated questionnaire designed to obtain a composite answer to the question: "Where are we 10 years after graduation?"

Nearly half of those on the class roster – 787 members of 1948 – responded to the appeal for information; and, as Mr. Kindler noted, all returned questionnaires "were sincere, aside from one classmate who has an annual salary of $2,000, 13 children, and two yachts."

■ Tabulation of the 787 responses showed that:
– 82 per cent had had military service (73 per cent in World War II and 12 per cent in Korea), but that active military status was retained in 1958 by only 2 per cent;
– 89 per cent were married (58 per cent to college graduates), the average number of children per family being 2.2 compared with a national per-family average of 1.9 for families headed by husbands in technical or professional employment.

■ Collective Mr. 1948 proved almost evenly divided between Conservatives, Middle-of-the-Roaders, and Liberals, and:
– 42 per cent of the Conservatives and Middle-of-the-Roaders "regularly attend church," and 10 per cent "never attend"; while
– 44 per cent of the Liberals "rarely attend," and 24 per cent "never attend."

■ Politically, 51 per cent are Republicans, 15 per cent Democrats, and 24 per cent Independents, *but* as to who should be the next President of the United States:
– 26 per cent preferred a Democrat, and 39 per cent a Republican; while among possible candidates:
– Nixon received 43 per cent of all ballots, Stevenson 15 per cent, Kennedy 13 per cent, Knowland 5 per cent, "all other Republicans 12 per cent and all other Democrats 12 per cent. Five loyal Alumni cast ballots for Dr. Killian."

■ As to the popularity of magazines: 42 per cent read *Time*, 37 per cent read *Life*, and ranging from 19 per cent to 12 per cent the other favorites in descending

(*Continued on page 372*)

* *Copies of this book may be obtained at $5.00 apiecce from Herbert S. Kindler, Director of Technical and Educational Services, Instrument Society of America, 313 Sixth Avenue, Pittsburgh, Pa. (Book printed by Isaac Goldmann Division, Publishers Printing–Rogers Kellogg Corporation.)*

# When a lawyer wants advice...

George Clark handles the life insurance program of J. V. Morgan (seated at desk, above), partner in a prominent law firm in High Point, North Carolina.

It's not surprising, therefore, that Mr. Morgan conferred with him on the effect that pending federal legislation would have on the integration of insurance with his personal estate. (This legislation would allow a self-employed individual a tax deduction on funds used to set up his personal retirement plan.)

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## TREND OF AFFAIRS

(*Continued from page 370*)

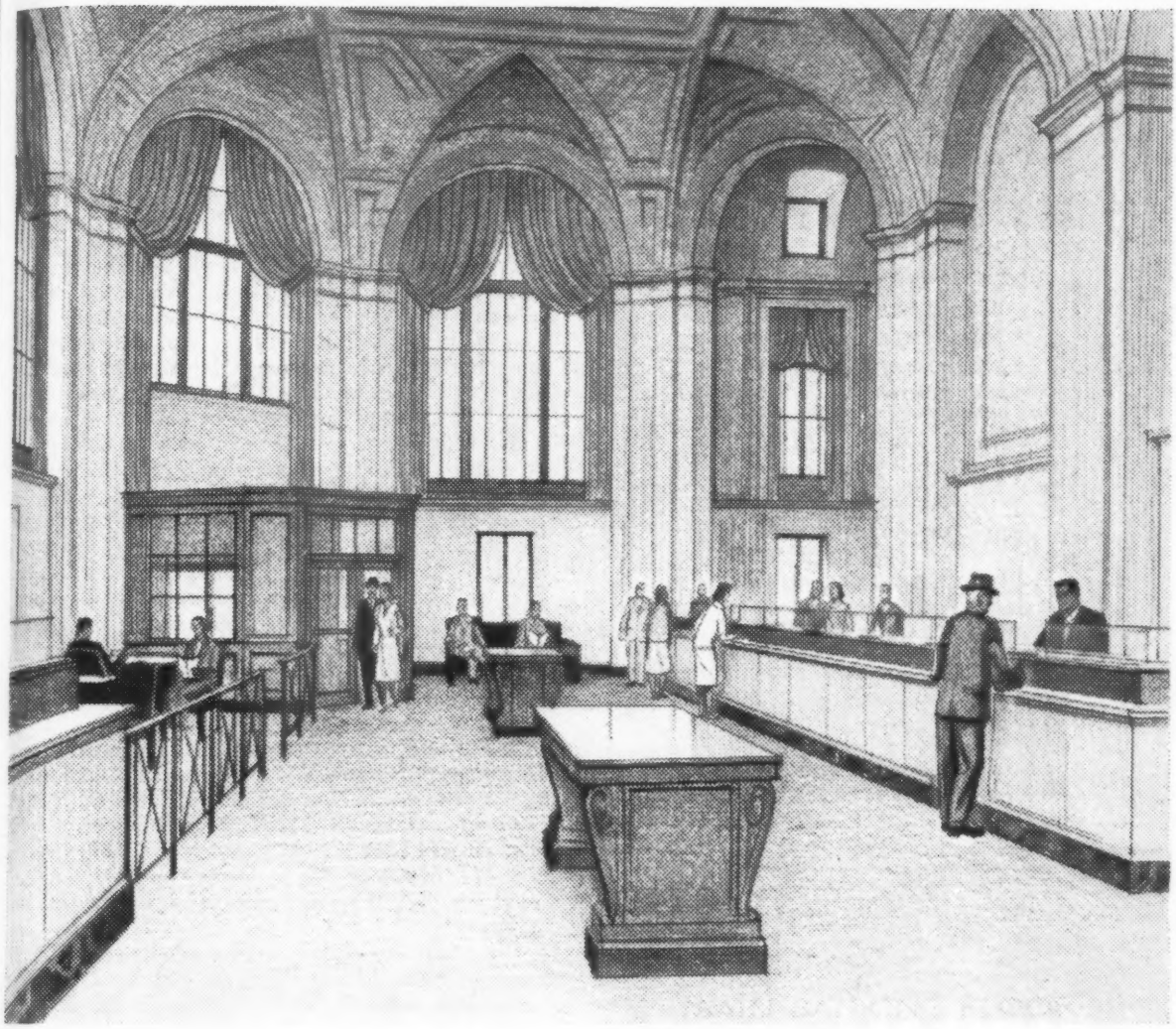
order were *Business Week, Scientific American, Fortune, Reader's Digest, New Yorker, Saturday Evening Post,* and *Newsweek.*

■ Comparing the U.S.S.R. and the U.S.A.:
– 45 per cent believed the Russians "superior" in technical education, and 33 per cent in weapons development;
– 33 per cent believed the Russians "inferior" in basic scientific achievement, and 84 per cent in "applied science for peaceful purposes";
– 45 per cent believed the two countries "about equal" in technical education, and 57 per cent "about equal" in weapons development and in basic scientific achievement.

■ Upon graduation, 84 per cent received gross annual salaries of $2,500-$3,000; and 10 years later the annual income "from primary vocations" averaged $10,600, its median being $10,000. "Vocational demands [required] overnight travel averaging 2.5 nights per month," but 27 per cent had to be "out-of-town only one night a month." Further data as to finances and scale of living included:
– 60 per cent own common stocks, and all but 2 per cent carry insurance;
– Three of every five have invested in houses, and 62 per cent have taken the precaution of preparing a will;
– 99 per cent own an auto, about 25 per cent own two, and 1 per cent own three; one man reported the ownership of an airplane;
– 54 per cent were opposed to credit buying except for the purchase of a house or car;
– 35 per cent employ domestic help, and 11 per cent have such help more than twice a week;
– 52 per cent expect continued inflation, and 20 per cent expect a "stable economy at higher levels";
– Assuming no inflationary trend, the incomes anticipated 25 years after graduation, in 1973, averaged $20,500, with a median of $17,000.

■ As to M.I.T. in "retrospect," over half retained the impression that the freshman year was the "hardest," and over 70 per cent that the senior year was the "most enjoyable." "In overwhelming numbers the Class of '48," as Mr. Kindler summarized, "believes the curricula in mathematics, science, and engineering is adequate . . . on the other hand, [only] 54 per cent were satisfied with the humanities curricula . . . almost two-thirds considered scholarship aids adequate . . . opportunity for personal faculty contact could be improved, replied 86 per cent of the Class . . . 59 per cent wanted more faculty guidance in curricula selection . . . two-thirds felt they had had adequate time for extra-curricular and social affairs." And finally:
– 86 per cent responded that "if they had it to do over again [they] would return to M.I.T."

(*Concluded on page 382*)



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## REMARKABLE "MASER" STORY

*(Concluded from page 360)*

which has been under way at Lincoln for several years. Swift implementation of the solid-state maser proposal was made possible by fundamental research on paramagnetic resonance conducted by James W. Meyer, and by the equally essential contributions of the materials group, in synthesizing large single crystals of accurately prescribed composition. Investigation of several suitable materials led Alan L. McWhorter, '55, and Mr. Meyer to obtain the first successful maser amplifier operation at 2800 megacycles per second. This work was extended by Mr. Kingston down to the ultra-high-frequency range by ingenious utilization of a super-conducting lead wire loop which produced a low-loss coupling circuit. Another cavity maser with exciting possibilities for astronomy was developed at 1400 megacycles by Stanley H. Autler and N. McAvoy.

The future potential of masers in radar astronomy lies at the higher frequencies, such as 2800 and 9000 megacycles, where the low-noise capabilities can be fully exploited. Coupled with still larger antennas and more powerful radars, they should enable us to contact more distant planets, to get more detailed information about the surface properties and rotation of Venus, and to track satellites, missiles, and space vehicles at greater ranges.

Broad-band masers at these higher frequencies can also be used in receivers for passive radio astronomy, in the detection of electrical noise emitted by distant radio stars. Masers from 1400 megacycles down should play an important role in studying the characteristic radiation of interstellar hydrogen, possibly out beyond the present optical limit of about two billion light years.

Other exciting applications for masers exist at frequencies higher than any previously explored. Lincoln researchers are now working on maser-like devices which will reach into the millimeter, sub-millimeter and even infrared range, to provide energy sources and detectors far superior to those now available. One of the inventors of the original gas maser, Herbert J. Zeiger, now at Lincoln, is engaged in work on infrared frequencies, and research in millimeter waves is actively in progress under the direction of Gerald S. Heller.

One objective of the Lincoln program is to extend the boundaries of knowledge by fundamental research on the properties of matter. Another is to develop and exploit as expeditiously as possible research results of potential practical value. The rapid development of the ultra-high-frequency maser system, used in the Venus experiment, emphasizes the value of the fundamental research program as a reservoir of talents and techniques.

---

*The Review erred in reporting the Venus experiment in its April issue. The report stated that when emitted the signals were 10,000,000 or more times as strong as when received. Echoes from the moon were 10,000,000 times as strong as those from Venus. The strength of the signals directed at Venus was about a million million million times that of those received back.*

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**EDUCATION:** University of Utah, George Washington University, Business and Law Schools.

**PREVIOUS EMPLOYMENT:** Member of U.S. Senator Elbert Thomas' staff. Staff member Senate Education & Labor, and Military Affairs Committees, 1943-1947.

**REMARKS:** One key factor in Rulon Rasmussen's successful transition from legislative fact-finding to life insurance selling was his fine business and law school background. This background and his congenial personality have helped Rulon top the million-dollar sales mark every year since 1949, the year after he became a New York Life representative. Today he is a Qualifying and Life member of the insurance profession's Million Dollar Round Table and has earned membership in the Company's Presidents Council—an honorary organization of New York Life's leading agents. If past experience is any indication, the years ahead look bright indeed for New York Life representative Rulon E. Rasmussen.

*Note*

Rulon Rasmussen, like so many other college alumni, is well established in a career as a New York Life representative. It offers him security, substantial income and the deep satisfaction of helping others. If you or someone you know would like more information on such a career with one of the world's leading life insurance companies, write:

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## CONTRASTS IN RUSSIA

(*Concluded from page 359*)

outside window displays of high heels and other unobtainable articles. Despite the propaganda about the joys of the workers' paradise, there is an air of sad and patient resignation everywhere. It is appalling to think of nearly 8,000,000 Moscow workers crowded into broken and sagging log houses, or the endless tiers of dirty gray and ugly yellow-ocher tenements, whole families to a room, using community kitchens and bathrooms, without privacy, quiet, or dignity. Everywhere are forests of radio and TV antennas, allowed in this austere economy not so much for entertainment as for propaganda and indoctrination.

There is now some free choice of jobs – not much of a privilege since the state controls where everyone lives by assigning living spaces. What is not allowed is to be idle. Everyone works who is able-bodied and not in school. Women and girls, besides taking their places in medicine, engineering, and the physical sciences, labor in shapeless dresses beside men in the factories and on construction jobs, lugging bricks, driving trucks or cranes, and digging in the ground.

The labor force is as carefully designed as everything else in this determined land. Workers are regimented and indoctrinated from infancy, and raised in an educational system tailored to the production of workers, like machine parts. The able ones become engineers and managers; the others, manual workers. The 30,000 engineering and science students at the magnificent Moscow State University are paid salaries while fitting themselves for their places in the production field. A member of a Science Service Jury of Soviet schooling reported, "The System as a whole is a very effective tool to achieve economic progress . . ."

But education does not end there! Newspapers and magazines remind the people incessantly of high production in the factories, the mileage of railways newly electrified, the size of Russian sputniks, and the glory of Russian achievement. Persuasion and incentive systems are everywhere. Factory workers are acclaimed and honored, and paid bonuses for exceeding production norms – and penalized for faulty work. Radios, posters, and newspapers din incessantly into everyone's mind, "Work – work – work!" "Work to survive!" "Work to beat America!"

I learned in a remarkable series of confidences that we are loved and admired by many of the people, despite their severe mental disciplining. I was implored to tell the American people not to become softened by our luxury – to keep vital and strong to resist the awful forces that have made labor-slaves and work-units of the Soviet people.

With these fervent expressions in mind, I now look about me to see wasteful uses everywhere of our resources, such as the feeding of our needlessly heavy automobiles. I see the makers of consumer articles planning their premature obsolescence by playing up style changes and prestige factors. I see the American economy tolerating rules throughout industry restricting the productivity of workers. We are a shockingly prodigal people!

In the face of the war that is, I wonder if we can much longer afford our extravagances. I think not!

## New Books from the *Technology Press*

### Noise in Electron Devices

*edited by Louis D. Smullin and Hermann A. Haus*

A discussion stressing the mathematical theory and basic physical phenomena of noise in electron devices. The book is a comparison of the various treatments of noise. Problems of noise due to thermionic emission, the general circuit aspect of noise in microwave tubes, and some of the detailed engineering solutions to the problems encountered in the design of low-noise traveling-wave tubes and space-charge control tubes are considered by specialists drawn from both industrial and academic fields. $12.00

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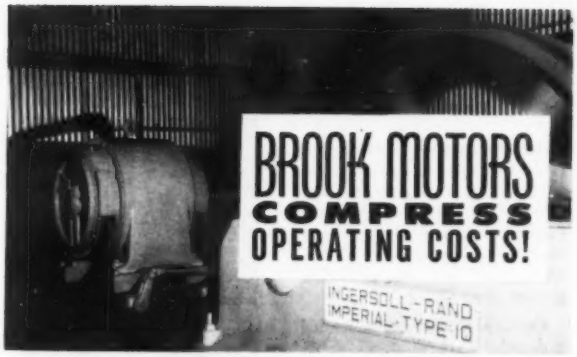


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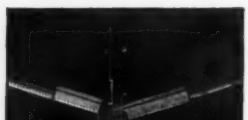

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## GOING TO RUSSIA

(*Continued from page 359*)

The passport will be taken for registration in each city visited thereafter but will usually be returned in a day or less. A guide-interpreter is assigned. Thereafter, the hotel's Intourist Office will be the focal point for all arrangements until the visitor goes to another city and becomes the responsibility of another Intourist Office. The visitor does not select the hotel in any instance.

Generally speaking, Intourist acts as a conveyer belt which follows a prearranged cycle to carry the visitor along in accordance with a predetermined, approved pattern for the individual, his group, or his category. Also generally speaking, the Intourist organization, being charged with responsibility for your visit and your impressions on leaving, will do everything it can for you within the framework of the bureaucracy and the system within which it operates.

**MAIL:** Getting a letter to or from the U.S. by air mail takes about a week. There are mailboxes on the street and in hotel lobbies. Stamps and air mail stickers can be obtained at the hotel postal desk. Neither the flavor nor the amount of glue on the stamps is very satisfactory and the air mail stickers have no glue at all. The usual gluepot with a sponge at the postal desk is best approached with caution. In addressing envelopes and postcards the order usual to us is reversed, for example:

USA — CwA
Massachusetts
Cambridge 39
77 Massachusetts Avenue

The return address is arranged similarly:

CCCP
Moscow
Hotel Metropole
Dr. Henry Jones

**MEAL TICKETS:** Intourist meal coupons are issued in booklets. Each page represents a day's meals and has four sections to be detached for breakfast, dinner, tea, and supper. Each coupon has a definite value in rubles. The value of the de luxe coupons is as follows: breakfast, 14 rubles; dinner, 30 rubles; tea, 4 rubles; supper, 25 rubles. The tourist coupons are worth slightly less than the de luxe. Menu prices are in rubles. You need not use the coupons for the meal for which they are designated. You can use breakfast coupons to pay for supper or dinner, or vice versa.

If you have Soviet hosts, you will doubtless be entertained and be able to accumulate surplus coupons. You can use these for reciprocal entertaining in Intourist restaurants. If, at the end of your visit, you still have coupons left over, you can trade them with the maître d'hôtel of the last hotel in which you stay for caviar, vodka, cigarettes, or chocolate to bring home as souvenirs. The coupons are not redeemable in cash.

**SUBWAY:** The subway in Moscow and Leningrad offers rapid and frequent service. The fare is 50 kopecks (5 cents at tourist exchange) to any point. Tickets can be bought singly or in books of 10. There is no difference in price for tickets bought in books

rather than singly, the inducements being convenience and timesaving. Traffic is very heavy at rush hours and international subway rules seem to apply.

**TAXIS:** Cabs are fairly plentiful and fares are modest. The drivers, as a rule, understand only Russian. In performance of their duties they display the zest internationally characteristic of their profession, with some display of slavic temperament and resentment of an environment where pedestrians overwhelmingly outnumber automobiles. Blowing the horn is not permitted and there are no speed limits. The real fun-loving visitor will particularly relish nocturnal taxi rides, when, in addition to the foregoing conditions, vehicles in the city operate with only parking lights.

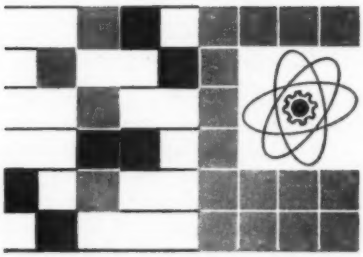
**TELEPHONE:** In principal cities, telephones operate on the dial system, and your hotel room will probably have a phone. Telephone numbers are composed of a letter and five digits: K 7-35-02. The letters on the dial are in the Russian (Cyrillic) alphabet. There will *not* be a telephone book in your room. At the administrator's (manager's) desk there may be a telephone book, but it is not likely to help you since phone numbers seem to be changed rapidly and the phone books are not. "Information" speaks only Russian and its service is neither rapid nor accurate. Be sure to ask, write, and keep the telephone numbers of your Russian hosts and acquaintances.

There are pay phones in stores, restaurants, and other public places, and there are outside phone booths on the streets – all without telephone books. Cost of a local call from a pay phone: 15 kopecks (1½ cents at tourist exchange). The hotel does not charge for local calls. Long-distance and overseas calls must be arranged in advance and for a specific time. The Intourist Office in the hotel will help you arrange a call.

**TELEVISION:** There will probably be a lounge in your hotel which has a television set. Programs are usually broadcast only in the evening. Although the picture is smaller than on the usual American set, it is generally clearer because of the greater number of lines per unit area. Although many of the programs are excellent, and there are no "commercials" in the ordinary sense, there is an abundance of inspirational and politically oriented programs.

**THEATERS:** In Moscow you will have your choice of ballet, opera, musical comedy, classical and modern drama, variety, puppet, and other types of theater. Other major cities offer most of these. The Intourist Office posts the schedule of performances, obtains your tickets, and arranges transportation. Prices are modest. To get good or, sometimes, any seats, you are advised to ask for tickets as far in advance as possible. If you wish to entertain Soviet hosts, the theater is much appreciated and Intourist will get tickets for both you and your guests.

**TIPPING:** Along with some other not officially recognized customs, tipping is expected in the U.S.S.R. You tip waiters and waitresses, taxi drivers, porters, washroom attendants, and checkroom attendants. The driver of the Intourist limousine, who might be coy about taking a tip, will be pleased with chewing gum for his children.

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## INTERPLANETARY FLIGHT PROPULSION SYSTEMS

*(Concluded from page 351)*

tems, and the shielding needed for nuclear reactions, for example, may also serve as shielding against damage by collisions with high-speed particles in space.

An interplanetary rocket should be capable of being restarted several times during a journey of several years. Its propulsive system must be capable of withstanding the high initial acceleration at take-off, be restricted in volume, be capable of applying torque or thrust in more than one direction, and be highly reliable. These are strenuous requirements. The engine laboratories in the future, Professor Sutton thinks, will be specially controlled satellites that will permit the operation of engines in the proper environment. "In fact," he said, "it is likely that a major portion of the satellites about the earth soon will become test devices for the development of hardware for interplanetary missions."

Professor Sutton concluded: "The environmental conditions will force us to use different materials, novel fabrication techniques, new failure-detection methods, or new lightweight tanks, and these engines will look very different if compared with present-day devices.

"Different stages of the same vehicle will use different engines, each designed to fulfill one or more specific interplanetary maneuvers in the best possible way. Standard interplanetary stages will be designed and modified slightly for different missions.

"It can be anticipated that there will be two basically different types of missions to any one of the planets. One will convey people and will require fast transit time, and therefore a large amount of excess energy. These will be multiple stage units and they will initially contain no nuclear rockets to avoid radiation exposure of people. The second category one might call 'freight vehicles' . . . and they will use electrical and nuclear propulsion.

"Because of the reliability problem of running a power plant for several years and because of the meteoric penetration problem, it will become desirable to use several propulsion systems on the same vehicle stage in such a manner that a failure of any one system will not cause a failure to achieve a mission. Mission requirements cannot be determined completely accurately and some spare energy capacity will have to be carried along. If this reserve is not needed during a specific flight, then it can be applied on the return trip to achieve a faster home journey.

"All the various systems seem to offer some growth potential in improved performance, efficiency, lower engine weights, or thrust. But the real need seems to be for a simple, lightweight, high-energy source to replace an airborn nuclear reactor. Because of the complexity and development difficulty of some of these devices, it may be a long time before they become sufficiently reliable to fly.

"The missions in terrestrial and lunar space can and will be performed with chemical rocket units. Those in the inner solar system will again be performed largely with chemical propulsion units for the immediate future, with some of the other propulsion engines becoming superior at a later time. However, for missions to the outer solar system and the far planets, it is essential that some high-performance rocket engine such as the electrical units be developed."

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## TREND OF AFFAIRS

(*Concluded from page 372*)

### Project Pipe Dream

■ B. T. Tucker, '62, spends a good bit of his spare time these days on a project that is far beyond the scope of freshman course work. With the help of Denys O. Akhurst, Assistant Professor of Electrical Engineering, he has designed a cloud chamber for studying atomic particles – a sophisticated version of the same apparatus he made at home last year in Amarillo, Texas. He will never be graded on how well it works, or quizzed on what he learns.

Mr. Tucker and Professor Akhurst didn't just happen on their mutual interest; every freshman received an invitation in mid-February to work with an expert in some field of science or engineering. "Available" professors in each field were listed, and the students took it from there.

Freshman spare-time research is not entirely new; a few M.I.T. laboratories habitually have "adopted" enterprising underclassmen. But more often their urge to experiment has been squelched under pressures of a prescribed and heavy first-year curriculum. This freshman plight was often lamented, but never so sharply defined as in a 1957 address by Edwin H. Land, Visiting Institute Professor: "He is told, the moment he arrives, that his secret dream of greatness is a pipe dream; that it will be a long time before he makes a significant, personal contribution – if ever." One of Dr. Land's suggested remedies, now become fact, was that freshmen be given the chance to rub shoulders with mature scientists in research.

Many of the 68 professors who volunteered for the experiment were immediately swamped. They expected one or two students apiece, and had as many as 20 calls in a day. Apparently the Class of 1962 has retained a healthy amount of creativity.

### Thanks from Foreign Students

■ The foreign students (over 700) now registered at M.I.T. said "thank you" for a full week this spring by arranging a series of lectures, exhibits, dances, and a soccer game. Abdel Karim Mirghani, senior member of the permanent mission of the Sudan in the United Nations, delivered the keynote address. The Institute has more foreign students in proportion to enrollment than any other American university.

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*and the prophet replied:*
*"It is well to give when asked, but it is better to give unasked, through understanding."**

# *Gifts by Will*

TO THE

## Massachusetts Institute of Technology

The tale is told of Almustafa, the prophet, who, having awaited for many years the ship that would return him to the place from whence he came, was making the final descent to the shore when the folk of Orphalese crowded about him. They besought him before departing to "disclose us to ourselves, and tell us all that has been shown you of that which is between birth and death."

With words of wisdom, an answer appropriate was given to the woman holding a baby, to the ploughman, to the merchant. Begged one, "Speak to us of GIVING," and the prophet replied:

> "It is well to give when asked, but it is better to give unasked, through understanding;
> And to the open-handed the search for one who shall receive is joy greater than giving. All you have shall some day be given;
> Therefore give now, that the season of giving may be yours and not your inheritors'."

Through the years the prophet's words have held true, for even today he who "through understanding" includes the MASSACHUSETTS INSTITUTE OF TECHNOLOGY as a beneficiary in his will can experience thereby a two-fold satisfaction. The successful culmination of his search for a worthy recipient and the anticipated results his generosity will assist in accomplishing. These satisfactions give an added value to the span of man's days and project his usefulness to his fellowmen far into the future.

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But the search, the finding, and the anticipated accomplishments are not enough; for without the properly-worded record, man's plans for the future may go awry. Hence the prophet's importuning, "— give now," should be heeded. The giving need not be an immediate physical transaction, for written directions replace the spoken word when the speaker is no longer present, and a donor can frequently make by will a gift which is larger than he can make while living. Truly, *"it is well to give when asked, but it is better to give unasked, through understanding."*

A booklet "Gifts by Will," outlining different forms of bequests to M.I.T., is available to you or to your attorney by writing to:

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* "The Prophet" by Kahlil Gibran

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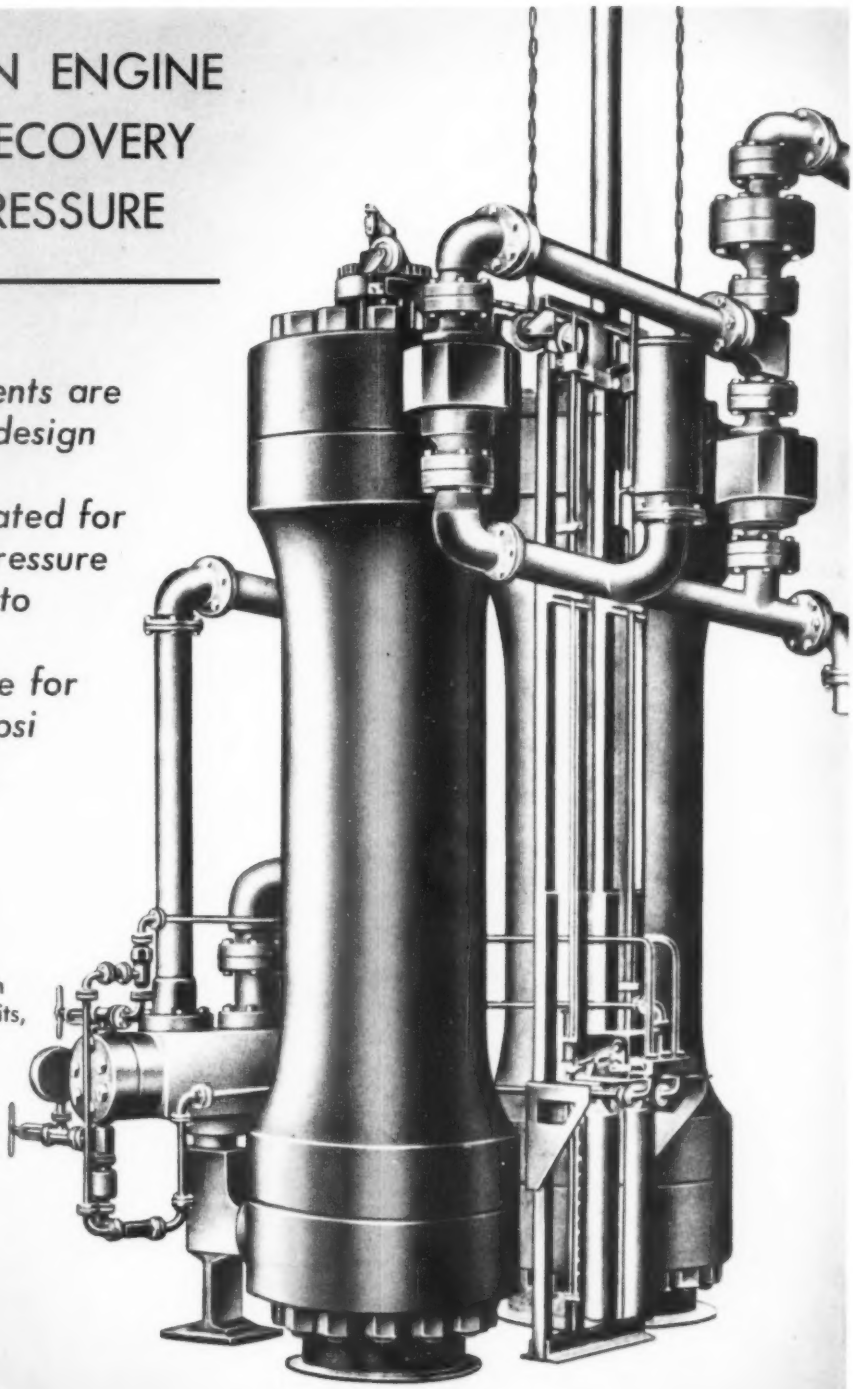

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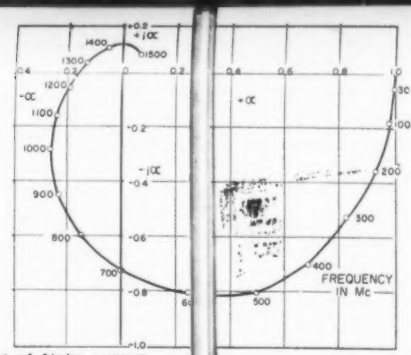


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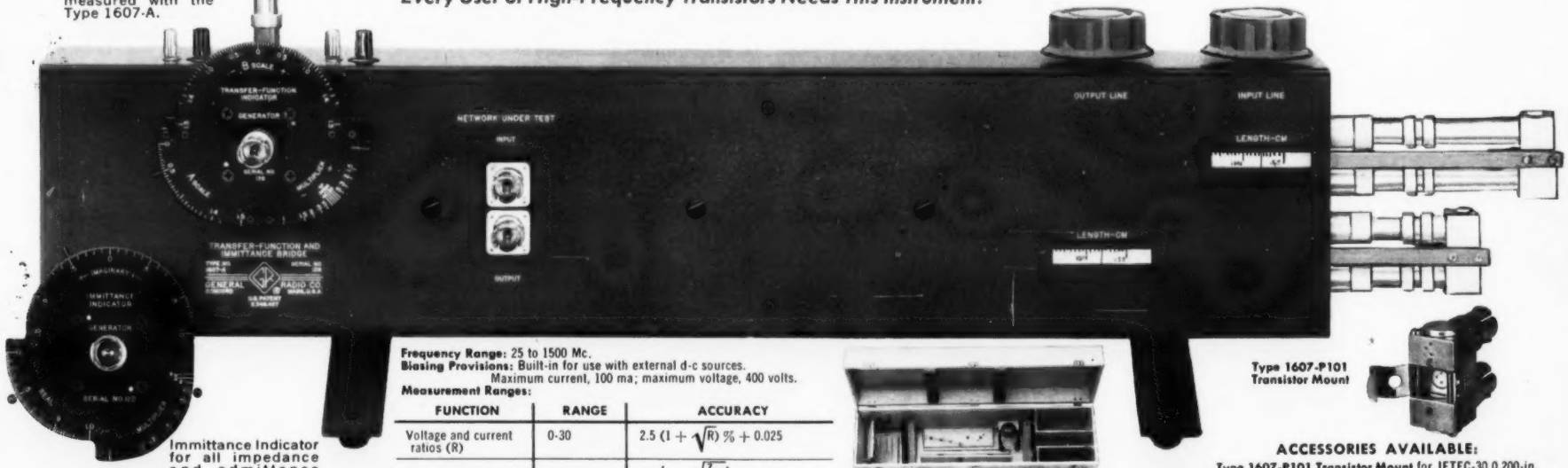
| TRANSISTORS | VACUUM TUBES | THREE- AND FOUR-TERMINAL NETWORKS |
|---|---|---|
| $\alpha$, $\beta$, $h_f$, $h_r$, $h_i$, $h_o$, $r'_b$, all short-circuit admittance and open-circuit impedance parameters. | $Y_m$ ($Y_{21}$), $Y_{12}$, $Y_{11}$, $Y_{22}$, etc. | $Z_{11}$, $Z_{22}$, $Z_{21}$, $Z_{12}$ $Y_{11}$, $Y_{22}$, $Y_{21}$, $Y_{12}$ $I_2/I_1$, $I_1/I_2$, $E_2/E_1$, $E_1/E_2$ |

★ A Basic Tool for Measurement of: Gain and Phase Shift of Amplifiers, Transmission Circuits, and Other Active and Passive Four-Terminal Networks; Impedance, Admittance, Reflection Coefficient, and VSWR of Components, Coaxial Systems, and other Grounded or Ungrounded Elements.

★ Equally Suited for Advanced Laboratory Investigations and Rapid-Quantity Production Testing

***Every User of High-Frequency Transistors Needs This Instrument.***





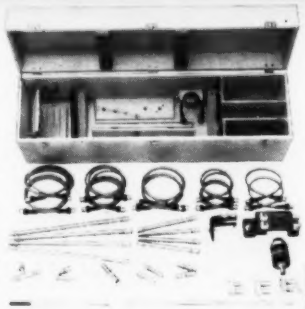


Immittance Indicator for all impedance and admittance measurements.

**Type 1607-A Transfer-Function and Immittance Bridge, $1665.**

**Frequency Range:** 25 to 1500 Mc.
**Biasing Provisions:** Built-in for use with external d-c sources. Maximum current, 100 ma; maximum voltage, 400 volts.
**Measurement Ranges:**

| FUNCTION | RANGE | ACCURACY |
|---|---|---|
| Voltage and current ratios (R) | 0-30 | $2.5\,(1+\sqrt{R})\,\% + 0.025$ |
| Transimpedance ($Z_{21}$) | 0-1500 ohms | $2.5\left(1+\sqrt{\frac{Z_{21}}{50}}\right)\% + 1.25$ ohms |
| Transadmittance ($Y_{21}$) | 0-600 mmhos | $2.5\left(1+\sqrt{\frac{Y_{21}}{20}}\right)\% + 0.5$ mmho |
| Impedance ($Z_{11}$) | 0-1000 ohms | $2.0\left(1+\sqrt{\frac{Z_{11}}{50}}\right)\% + 1.0$ ohm |
| Admittance ($Y_{11}$) | 0-400 mmhos | $2.0\left(1+\sqrt{\frac{Y_{11}}{20}}\right)\% + 0.4$ mmho |



**ACCESSORIES SUPPLIED:**

Frequency-Range Extension Unit; Two Calibrated Transfer-Function and Immittance Indicators; Terminations; Standards; 10-db Attenuator; Air Lines, Patch Cords, and other Coaxial Elements.



**Type 1607-P101 Transistor Mount**



**ACCESSORIES AVAILABLE:**

**Type 1607-P101 Transistor Mount** for JETEC-30 0.200-in. pin-circle triode with grounded-base arrangement. **$60.**

**Type 1607-P102 Transistor Mount** for JETEC-30 0.200-in. pin-circle triode with grounded-emitter arrangement. **$60.**

**Type 1607-P201 Tube Mount,** 7-pin miniature, grounded cathode for 6AF4, 6AF4A, 6AN4, 6T4, and other tubes with the same pin connections **$75.**

Other mounts for tetrodes, 0.100-in. pin-circle triodes, and ungrounded components are in development and will be announced soon.

**Generator and Detector:** G-R Unit Oscillators and Type DNT Detectors are recommended.

## GENERAL RADIO COMPANY

275 MASSACHUSETTS AVENUE, CAMBRIDGE 39, MASSACHUSETTS

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N. J. WHitney 3-3140

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